ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

APRIL 27, 1939

Hydroelectric Power Station, North Platte, Neb., Water Power in Nebraska, page 41

Including CONSTRUCTION COSTS
70 pages of bidding and estimating data
This Issue $2 per Copy

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ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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THIS WEEK

THIS WEEK'S ISSUE brings to the reader the largest issue he has had in several years, being given over in large part to the 1939 edition of Construction Costs. But the issue contains other matter than data for cost estimating purposes which is worthy of note.

● Nebraska's "Little TVA" is the subject of a first hand study by V. T. Boughton of the *ENR* staff. His findings should help to put that remarkable undertaking into a clearer light than it has been heretofore.

● An unusual feature of the grouting work at Chickamauga Dam was the use of bentonite. Experience with mixtures of bentonite, cement and sand is given in the article on p. 59.

● Highway maintenance as our biggest highway job is the subject of a series of articles by C. S. Hill beginning in this issue. The series is commended to readers outside the highway field.

THINGS TO COME

THE FULL FINDINGS of the board set up to report on the big slide in Fort Peck Dam are to be given in the May 11 issue. They are to be supplemented by a statement by H. W. Richardson of the *ENR* staff as to the work now in progress at the dam since work on the board's recommendations began. The first news of the board's findings is given in the news pages of this issue.

SUPER HIGHWAYS are the subject of a report to Congress by the Bureau of Public Roads which is now in the President's hands. A summary of the bureau's findings will be given in the May 11 issue.

SHAFT SINKING by freezing, recent developments in an old method that has been little used in this country, will be the subject of an article to be published soon.

BEFORE STUCCO

Modernizing miracle transforms noted Los Angeles Auditorium

THE REMODELING of this center of business and culture in Los Angeles is a tribute to architects and builders of today—and the modern materials they use.

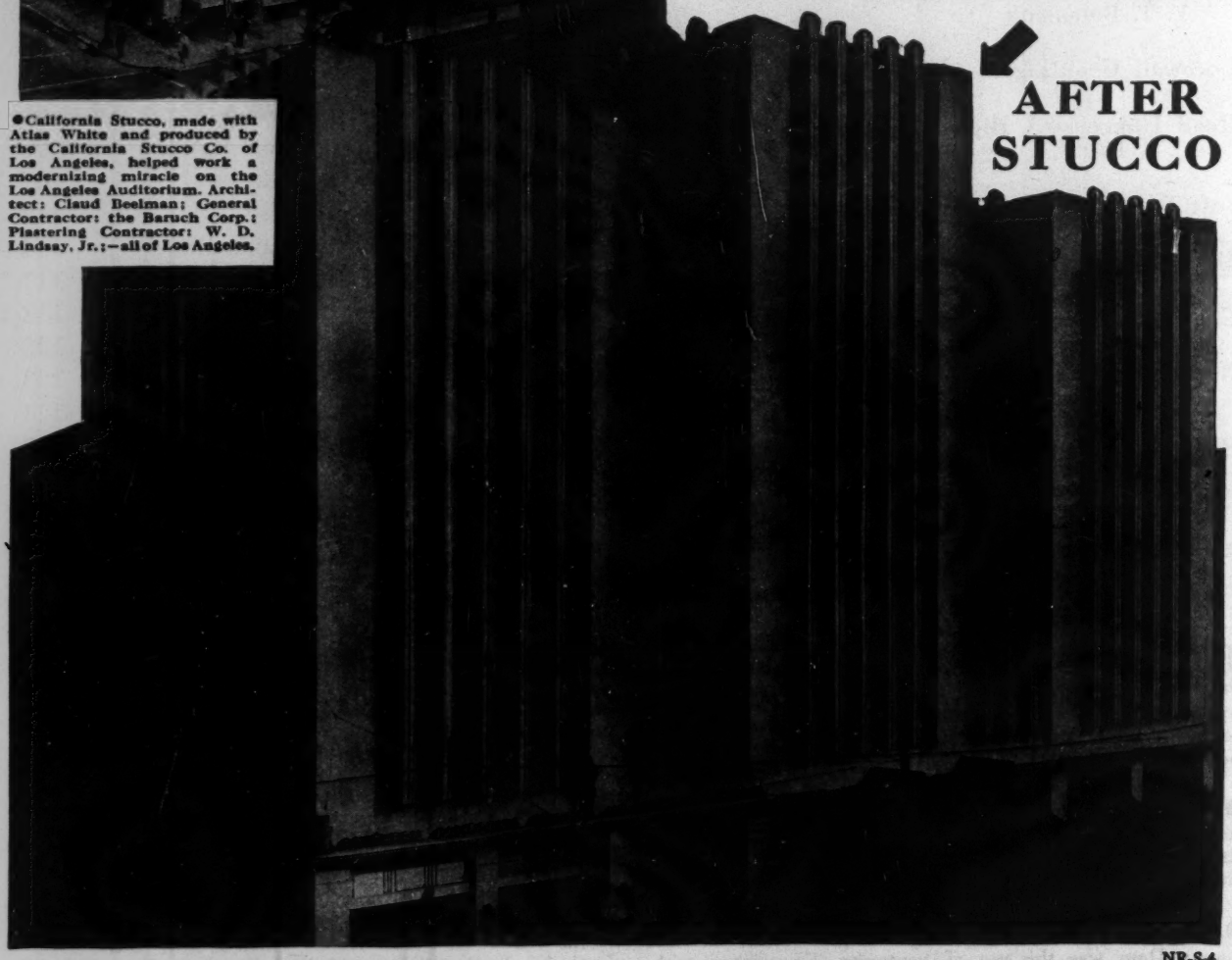
Stucco is one of these materials. Here, it is factory-prepared stucco made with Atlas White portland cement which wraps this Auditorium in a modern, permanent, fire-and weather-resisting wall.

Consider Atlas White stucco for your next modernizing job and for new buildings. You can specify it in white and a range of colors. Both initial and maintenance costs will be surprisingly low. Let us send you information on the many ways in which stucco is being used today. Write Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, N.Y.C.

A FACTORY-PREPARED STUCCO IS PREFERABLE

●California Stucco, made with Atlas White and produced by the California Stucco Co. of Los Angeles, helped work a modernizing miracle on the Los Angeles Auditorium. Architect: Claud Beelman; General Contractor: the Baruch Corp.; Plastering Contractor: W. D. Lindsay, Jr.;—all of Los Angeles.

AFTER STUCCO



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STUCCO MADE WITH **Atlas White** PORTLAND CEMENT

ENGINEERING NEWS-RECORD

NEWS

Volume 122 APRIL 27, 1939 Number 17

Arkansas Earth Dam Fails During Construction

About 125 ft. of an earth dam being built on Short Mountain Creek as a water supply project for Paris, Ark., was washed out Apr. 16 when a record-breaking rainfall of 5.35 in. in 15 hours caused the creek to rise 5 ft. in 30 min. The municipal pumping plant below the dam was seriously damaged, causing the town to be left without water for about three days.

The dam, which was about 75 per cent completed, was a 740 ft. long earthfill with a design height of 57 ft. At the point where the failure occurred it had been brought to a height of 43 ft. Damage to the dam is estimated at $15,000 to $18,000. It is being built for the city by the S. E. Evans Construction Co. at a cost of $165,000.

President to Reorganize All Works Agencies

All regular and emergency public works bodies to be consolidated into the Federal Works Agency

Acting under the authority of the recently approved reorganization act, President Roosevelt on April 25 transmitted to Congress his first reorganization plan, which will go into effect in sixty days unless disapproved by a majority vote of both houses or postponed by the intervening adjournment of Congress. Under the law the plan must be considered as a whole, without either major or minor changes.

Of outstanding interest to engineers it creates, in all but name, a new department of public works to take over the functions and personnel of the following agencies: Bureau of Public Roads, public buildings branch of the Procurement Division; branch of buildings management of the National Parks Service, U. S. Housing Authority, Public Works Administration, Works Progress Administration (with the single exception of the National Youth Administration).

The new governmental division is to be known as the Federal Works Agency and will be headed by a federal works administrator to be appointed by the President with advice and consent of the senate at a salary of $12,000 per year. The administrator in turn will appoint an assistant federal works administrator at $9,000.

Other recommendations of the President include the setting up of a federal security agency, a federal loan agency, and strengthening of the White House executive office.

Assigned to the federal security agency are present governmental agencies intended to "promote social and economic security, educational opportunity, and the health of the citizens of the nation." Social Security Board, U. S. Employment Service (from labor), Office of Education (from interior), Public Health Service (from treasury), National Youth Administration (from WAP) and Civilian Conservation Corps.

Grouped in the federal loan agency are "those independent lending agencies of the government which have been established from time to time for the purpose of stimulating and stabilizing the financial, commercial, and industrial enterprises of the nation": Reconstruction Finance Corporation, Electric Home and Farm Authority, Federal Home Loan Bank Board, Fed-

(Continued on page 46)

ENR Staff photo

TALLMAN'S ISLAND DISPOSAL PLANT OPENED

FOCAL point of interest at the dedication of the Tallman's Island sewage disposal plant Apr. 22 was the power building which houses the largest sludge engine installation in America. One battery of the engines which drives the air blowers is shown above. There are two batteries of four engines with a total capacity of 3,500 hp.

The Tallman's Island plant is the third unit to be completed in a program of sewage treatment involving construction of more than 30 plants. It was designed by the New York City Department of Public Works. Details of the plant are to be found in *ENR*, Sept. 30, 1937, p. 541, and Apr. 20, 1939, p. 536.

Investigating Board Recommends Reconstruction of Fort Peck Dam

Slide of Sept. 22 attributed to foundation failure—Rebuilding with flattened slopes recommended—Two members dissent

Shearing failure of the shale underlying the valley fill which forms the foundation of Fort Peck Dam is declared to have been the cause of the great slide of Sept. 22, 1938, in the report of an investigating board of engineers and geologists appointed immediately after the accident. The board recommends that the failed part of the dam be rebuilt with a rolled-earth core and with an upstream embankment of flatter slope than that of the original design.

Seven of the nine members of the board joined in the majority report: Joel D. Justin, chairman; Arthur Casagrande, Glennon Gilboy, Irving B. Crosby, William Gerig, C. W. Sturtevant, and W. H. McAlpine. An extended minority report by Thaddeus Merriman expresses a different opinion on the ultimate cause of the accident, and recommends more extensive reconstruction and a lowering of the pool level 50 ft. by cutting down the spillway. The ninth member of the board, Prof. Warren J. Mead, recommends that the dam be abandoned, on the ground that the value of its purpose does not justify the risk which any engineering structure involves.

Description of dam

Fort Peck Dam is a hydraulic fill embankment 220 ft. high by 9,000 ft. long across the Missouri River, 20 miles south of Glasgow, Mont., under construction since 1933, to store about 20 million acre-feet of water for flood control, navigation and power, and to cost about $100,000,000. At the time of the slide hydraulic pumping from the valley-bottom fill to the dam embankment had progressed without incident to within 30 ft. of intended crest elevation. River closure having been completed, the core pool extended the full length of the main dam. The slide occurred at or directly adjacent to the right (east) abutment and involved about 2,000 ft. of length of the dam, the entire upstream part of the embankment together with the adjacent core and the upper part of the downstream embankment going out. Eight men lost their lives in the slide.

For description of dam see *ENR* Aug. 29, 1935; for reports of failure see *ENR* Sept. 29, 1938, p. 385; Oct. 6, 1938, p. 417; Oct. 13, 1938, p. 452; Oct. 27, 1938, p. 508.

As to cause, the board limits itself to saying that the slide "was due to the fact that the shearing resistance of the weathered shale and bentonite seams in the foundation was insufficient to withstand the shearing force to which the foundation was subjected. The extent to which the slide progressed upstream may have been due, in some degree, to a partial liquefaction of the material in the slide."

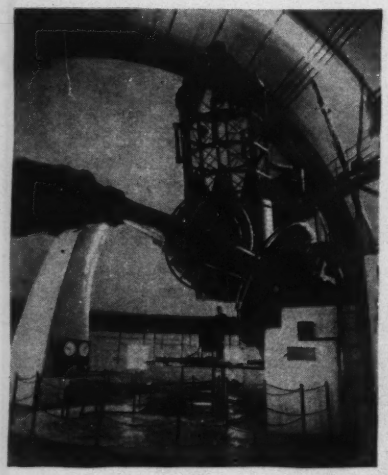
Reconstruction plans

The board recommends reconstruction of the failed section by replacing the washed-out part of the core by rolled fill of glacial till and giving the upstream bank slopes ranging from 1 on 3.5 to 1 on 23. The top of the dam from El. 2,250 to 2,275.5 is to be built of rolled fill. It also recommends flattening the upstream slope of the undisturbed part of the dam by adding hydraulic fill of coarse material to form a berm about 500 ft. wide extending up to midheight of the dam.

Merriman blames uplift

The Merriman dissenting report ascribes the failure to outward sliding of the upstream bank made possible by hydrostatic uplift under the dam, arising from water that seeped into cracks and joints in the weathered surface portion of the shale and could not escape because of a tight mud or clay layer formed on the surface of the shale. In accordance with this view Mr. Merriman proposes more extensive reconstruction than recommended by the board's report, including removal of weathered shale from the failure area and the surface of the east abutment. In addition he proposes that the spillway be cut down by 50 ft. and the gates removed.

(*A fuller abstract of the report will be printed in a later issue of Engineering News-Record.*—ED.)



A BIG TELESCOPE FINISHED

Although it will be pushed into third place when the 300-in. Palomar telescope is completed, the 82-in. reflecting telescope of the McDonald Observatory will be the second largest in the world when it is formally dedicated May 5. The telescope is being installed in the University of Texas' new observatory situated at an elevation of 6,800 ft. on Mt. Locke in the Davis Mountain in western Texas.

Both the observatory and the telescope were designed and built by Warner & Swasey Co., of Cleveland. The observatory was completed last year and the 3-ton mirror was finished in February. The observatory is a cylindrical steel structure 71 ft. high surmounted by a revolving 62 ft. hemispherical dome. The telescope will be sighted through an 18-ft. rectangular opening extending from the base of the dome to its zenith.

Iowa Legislature Hits Gas Tax Diversion

A resolution proposing a constitutional amendment to pledge all future gasoline tax and motor vehicle license fees to construction and maintenance of highways has been passed by both houses of the Iowa legislature and sent to the Governor. To become effective, the measure must be passed again by the legislature in 1941 and accepted at the 1942 general election.

The Governor a week earlier signed a bill providing that all receipts to the primary road fund over $16,000,000 be used for improvement of the secondary road system.

• • •

State Preference Law Held Void on PWA Job

The Public Works Administration has ruled that the Wyoming law granting a 5 per cent preference to Wyoming bidders on public works contracts may not be applied to projects receiving federal aid.

The Northwestern Engineering Co. of Rapid City, S. D., recently submitted the low bid, $312,900, for construction of a PWA high school project at Laramie, Wyo., while a Wyoming contractor bid $321,000. PWA ruled that the contract must be awarded to the South Dakota firm.

Half Million Houses Held Needed Annually

Commerce department study correlates vital statistics with housing construction

Construction of 550,000 urban dwelling units and 40,000 farm dwelling units will be needed each year over the next five years based on probable increases in family population. This is the conclusion of a report prepared for the National Resources Committee by Lowell J. Chawner, chief of the Economic Research Division of the Bureau of Foreign and Domestic Commerce.

The study, believed to be the first of its type, correlates fluctuations in residential construction with changes in the number of marriages and divorces, deaths and migrations, and family income. It also contains new estimates of the number of families which may be expected in the United States during each five year period through 1960.

Over the next ten years, Chawner estimates, the number of families will increase by 400,000 each year, and during the following decade the annual increase will be between 350,000 and 400,000. In 1900 there were 15,976,000 families in the country, and 31,827,000 in 1935; it is estimated there will be 34,221,000 in 1940, 36,591,000 in 1945, and 42,649,000 in 1950.

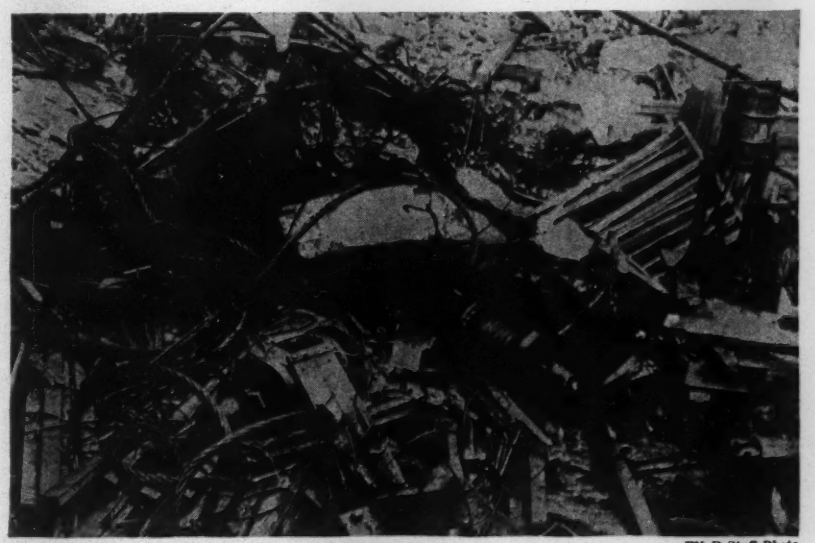
An analysis is included of the demand for new housing between 1900 and 1937. Peaks in residential construction, it is revealed, tend to lag a year or more behind peaks in demand created by the increasing number of new families, and economic influences such as family income and cost of ownership accentuate the trends established by population changes.

During the years 1923-1932, increases in dwelling units exceeded the increase in number of families, but since 1933 this has been reversed.

• • •

Bid Acceptance Held Equivalent to Contract

Acceptance of a bid and notification to the contractor that his bid has been accepted has the effect of putting a contract in force, the Minneapolis district court held in a suit brought by Harris Bros. Co. of Minneapolis to compel the Minneapolis School Board to carry out a contract. The board had accepted a $14,400 bid from Harris for installation of heating and plumbing equipment in a high school building and had notified the company of its acceptance. The board later held up formal completion of the contract.



EN-R Staff Photo

SHOVEL BECOMES SCRAP IN 175-FT. FALL

A 175-FT. DROP down the steep sides of the gorge at Ruby Dam in Washington recently made scrap out of the body of a 2-yd. gas shovel. The rig was being hoisted out of a deep foundation hole by a highline cableway when the U-bolt connection between the track cable and head tower gave way. Bouncing down the side of the gorge, the remains came to rest at the bottom amid a tangle of the track cable, endless line, hoist line, and carriage. A grout pump picked off a ledge was also demolished, and the whipping track cable tore off part of the concrete plant roof. Though 30 men were working in the bottom of the hole, not one was seriously hurt. General-Shea-Columbia Const. Co. is contractor on the project.

Record Low Rentals On Indiana Project

USHA says $2.20 per week for 5-room house is lowest ever charged in Northern city

The lowest rentals charged during this century for new housing in a northern city will be paid by tenants of the 83-unit USHA housing project in Vincennes, Ind., Nathan Straus, USHA administrator, announced Apr. 20. Based on construction bids which have just been approved, it is estimated that the rental for a typical 5-room house will be $2.20 per week.

The unit costs of these represent new lows for public housing in the North. The overall cost, including the price of land, will be about $3,500 per dwelling unit and the net construction cost $2,300. Construction cost per room will be about $500.

The general construction contract for the project has been awarded to Elmer A. Brunson of St. Louis for $175,000.

The 83 dwellings will consist of one-story double houses constructed with concrete walls, joists, and floors and with framed roofs covered with asbestos shingle. All ceilings will be plastered. Heat will be provided by individual coal burning cabinet heaters.

New Orleans project bids

USHA on Apr. 18 approved bids for the 723-unit Magnolia St. project in New Orleans. A bid of $2,479,000 was submitted by R. P. Farnsworth & Co. of New Orleans for construction of the 55 buildings comprising the project and demolition of existing structures. On this basis the net construction cost per dwelling unit will be $2,945 and the cost per room $748.

USHA's "net construction cost" includes the structural, plumbing, heating, and electrical cost of dwellings and is intended to be equivalent to the private residential costs compiled by the Bureau of Labor Statistics.

• • •

New Earthquake Damages Chilean Towns

Earthquakes of an intensity reaching Grade 10 last week did serious damage in the towns of Copiato and Caldera in northern Chile. At Copiato, ten buildings, including parts of the mining bureau there, two schools, and a hospital, were destroyed and it is reported that nearly half the buildings in the city have been so badly shaken they may have to be demolished. Copiato was almost completely destroyed in the 1922 earthquake.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

PWA DISBURSEMENTS for the first quarter of 1939 totaled $114,000,000. This sum was advanced in response to requisitions to cities, counties, and states undertaking PWA projects and applied on loans and grants made by PWA. In addition, $140,000,000 was released by project sponsors.

OF THE COMMUNITIES voting on bond issues to meet the local share of the cost of projects in the current PWA program, 81 per cent approved the issues. This was revealed Apr. 24 by a nationwide survey undertaken by PWA.

The projects under the 1938 program required 3,210 bond issue elections, and in 2,625 of these the bond issues carried. A total of $630,054,000 worth of projects was involved in the elections and $413,937,000 were approved.

THE FEDERAL POWER COMMISSION announced Apr. 24 that studies of ten cases of major power failures had demonstrated that even local breakdowns remote from state lines invariably interfere seriously with interstate commerce and federal activity. "As loads build up and generating station capacities and machine sizes increase," the report says, "while the power is still handled at switching stations . . . originally built during the war or post war period, the equipment at these points becomes progressively more inadequate, and breakdowns will become increasingly common unless there should be speedy modernization of structures and equipment at all switching points."

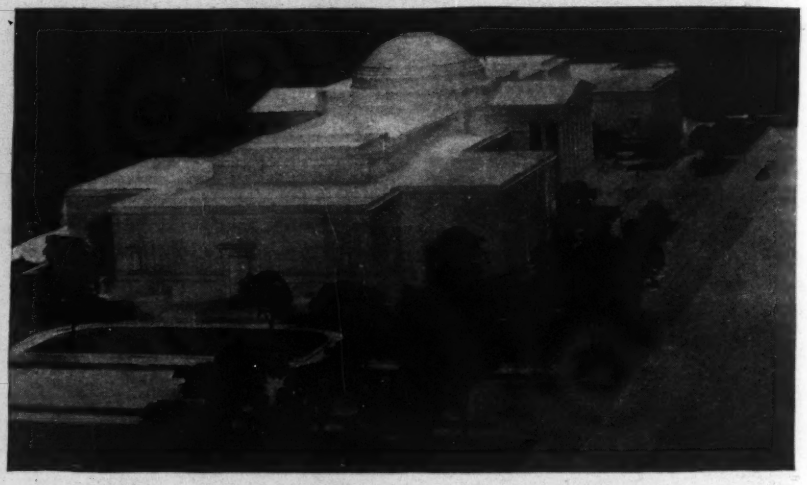
• • •

Yale Offers Fellowships In Traffic Engineering

The Bureau of Street Traffic Research of Yale University is offering nineteen graduate fellowships in street and highway traffic engineering for the academic year beginning next September. The fellowships, which carry a stipend of $100 per month for eight months plus tuition, are made possible through a grant from the Automotive Safety Foundation, and Alfred P. Sloan, Jr.

Seven of the fellowships are restricted to employees of traffic control divisions of state highway departments, while the remaining twelve are open to employees of organizations having to do with traffic control as well as to graduate students seeking a career in traffic engineering. Applicants for all of the fellowships must be graduate engineers between the ages of 23 and 35, and preferably they should have had some practical experience.

Applications for the fellowships should be sent before June 1 to Maxwell Halsey, Room 315, Strathcona Hall, Yale University, New Haven, Conn.



HOW THE NATIONAL ART GALLERY WILL LOOK

THIS 20-FT. MODEL of the $15,000,000 National Gallery of Art which is under construction in Washington with funds provided by the late Andrew W. Mellon, was recently placed on exhibition in Washington.

The building will be 785 ft. long and will provide a total of 500,000 sq. ft. of floor space. Exterior walls are to be of rose-white Tennessee marble. The building was designed by the late John Russell Pope, and the architectural work has been carried on since his death by Otto R. Eggers and Daniel P. Higgins. J. L. Stuart, Pittsburgh, is the engineer and Marc Eidlitz & Sons, New York, are the general contractors.

The building is to be opened in 1940.

• • •

Powerful Plan Body Proposed in Chicago

The Chicago Planning Commission would be established as an official body with authority to carry out improvements and developments under an ordinance now before the city council of Chicago. The present planning commission, organized in 1909 and composed of about 250 members, has no powers defined by ordinance but can only make recommendations. Under the proposed ordinance, which has been approved by the existing commission, the number of members would be limited to about 30.

In connection with this change, Mayor Kelly has proposed that the suburban districts be represented on the reorganized commission. The mayor points out that many of the city's public utilities are of importance to these suburban towns as well as to the city.

President Reorganizes Works Agencies

(Continued from page 43)

eral Housing Administration, Export-Import Bank.

Assignments to the executive office are designed to give the President more direct control over the three management arms of the governmental establishment: Budget, planning, and personnel. Agencies affected are: The Bureau of the Budget (from treasury), National Resources Committee (independent and now temporary), Federal Employment Stabilization Office (from commerce).

The National Resources Committee, which will absorb the Federal Employment Stabilization Board, is renamed the National Resources Planning Board. Transfer of the civil service commission is prohibited by an exemption in the reorganization bill but the President serves notice on Congress that one of his six assistants will be chosen to act as liaison agent on personnel management.

The message estimates the present administrative costs of the agencies affect at $235,000,000 annually, and estimates that a saving of from $15,000,000 to $20,000,000 per year will be affected by the new arrangement besides achieving greater efficiency and convenience to local governments and citizens in dealing with the federal government.

LABOR NOTES

BUILDING LABORERS in East St. Louis, Ill. went on strike Apr. 17 to enforce demands for a wage increase from $1 to $1.25 an hour and renewal of a contract with the Associated Builders of East St. Louis.

BUILDING MATERIAL truck drivers in Chicago went back to work last week after a five-day strike which had held up a number of projects there (*ENR*, Apr. 20, 1939, p. 7). The strike was settled by a compromise proposal under which the men's pay will be increased about 50 cents per day.

A FIVE-DAY STRIKE called by the CIO Mine, Mill and Smelter Workers Union at the Yuba Narrows debris dam near Smartsville, Calif., collapsed Apr. 12 when about 70 non-union workmen went to work. Increased wages and a closed shop agreement were sought in the strike.

The Arundel Corp. and the L. E. Dixon Co., contractors on the dam, have filed suit at Nevada City against the CIO union and three AFL unions asking damages of $25,000 for the interruption of work and an injunction against picketing.

MINIMUM WAGES have been established by the Pennsylvania Turnpike Commission for workmen on the Pittsburgh-Harrisburg toll road. The minimums range from 52½ cents per hour for unskilled labor to $1.50 for structural iron and steel workers. Chairman Jones of the commission said that "In no instance are the wages lower than prevailing wages in the region . . . and in most cases they are higher."

• • •

Road Bureau Investigates Fatal Bridge Failure

Two engineers have been appointed by the U. S. Bureau of Public Roads to investigate the failure Mar. 29 of the Clear Creek Bridge on the Vicksburg-Jackson highway in Mississippi in which sixteen people were killed. Charles Senour has taken a leave of absence from his post on the Mississippi River Commission to participate in the inquiry. The other investigator is B. M. Duncan, formerly chief engineer of the Florida state highway department and recently a delegate to the Pan American Highway Conference in Chile.

Through traffic over the Vicksburg-Jackson highway was resumed Apr. 12 when a temporary bridge was completed to replace the washed out span.

BAD FUEL FOR AN INCINERATOR

AFTER AN EXPLOSION that damaged one of the two furnaces of the Charleston, S. C. incinerator, inspection of a day's incoming garbage produced this alarming display of loaded ammunition. The large shell is a French 37 mm. The source of the ammunition could not be traced.

J. Frank Morse, superintendent of the Charleston incinerator, is showing the ammunition to Bernard M. Thomson, city engineer.

Fifteen Air Bases Are Authorized

Congress approves three-year naval air base program costing $66,800,000

Continuing measures for the expansion of national defense, the Senate on April 19 passed a bill authorizing the expenditure of $66,800,000 for the construction (including land acquisition) of fifteen naval air bases, including an aeronautical engine and materials laboratory at the Naval Aircraft Factory in Philadelphia. Senate amendments were accepted by the House, completing Congressional action.

The program will be spread over three years. Tentative allotments, subject to adjustment by the Secretary of the Navy, are:

Kaneohe, T. H.	$5,800,000
Midway Island	5,350,000
Wake Island	2,000,000
Johnston Island	1,150,000
Palmyra Island	1,100,000
Kodiak, Alaska	8,750,000
Sitka, Alaska	2,900,000
San Juan, P. R.	9,300,000
Pensacola, Fla.	5,850,000
Norfolk, Va.	500,000
Tongue Point, Ore.	1,500,000
Pearl Harbor, T. H.	2,800,000
Philadelphia, Pa.	1,800,000
Jacksonville and Banana River, Fla.	17,000,000
Quonset Point, R. I.	1,000,000
TOTAL NOT TO EXCEED	$66,800,000

The bill is the first step in carrying out the recommendations of a special board of naval officers who found that additional shore facilities totalling $326,216,000 are needed to provide for the needs of the enlarged navy contemplated under present plans.

• • •

Committee Approves River-Harbor Bill

A river and harbors bill authorizing 60 projects with a total estimated cost to the United States of $69,660,000 has been favorably reported by the House committee on rivers and harbors. These projects call for no appropriation for the coming fiscal year and are intended to be appropriated for over a number of years. River and harbor funds are ordinarily made available in a lump sum to the War Department and allotted by the Chief of Engineers to projects previously authorized.

Among the larger projects authorized in the bill are the following:

New Jersey intra-coastal waterway	$2,100,000
Winyah Bay, S. C.	1,260,000
Mississippi River at the mouth	4,200,000
Louisiana-Texas intra-coastal waterway	5,200,000
Guadaloupe River, Texas	8,500,000
Mississippi River between Ohio and Missouri rivers	10,290,000
Calumet-Sag channel and Indiana harbor and canal	25,900,000
Missouri River Sioux City to mouth	6,000,000
Oswego Harbor, New York	1,000,000
Sacramento River flood control, Calif.	1,600,000

OBITUARY

JOHN A. MACDONALD, who resigned last year from his post as highway commissioner of Connecticut, died Apr. 18 at the age of 48. Macdonald graduated in 1914 from Valparaiso University with a civil engineering degree and after three years' work with various construction companies and the New York, New Haven & Hartford R.R., he was appointed deputy commissioner of the Connecticut Motor Vehicle Department. He held this post until 1923 when he was made highway commissioner.

CHARLES S. BOARDMAN, consulting engineer at Pittsburgh for the Carnegie-Illinois Steel Corp. and responsible, early in the century, for important advances in the design of steel sheetpiling, died in Pittsburgh Apr. 19 at the age of 65. Boardman joined the civil engineering department of the Lackawanna Steel Co. in 1901 and four years later he joined the Buffalo firm of C. C. Conkling, consultants to Lackawanna. The sheet piling which was then available had a bulb-shaped joint that was not tight and lacked tensile strength; Lackawanna made no sheetpiling. Boardman designed the original Lackawanna sheeting with what was known as a three-point contact in the interlock. Shortly afterward, during the raising of the battleship Maine from Havana Harbor, Boardman was the field man on construction of the cellular sheetpile cofferdam used.

HENRY B. ALVORD, head of the department of civil engineering at Northeastern University in Boston, died there Apr. 20 at the age of 53. Alvord graduated from Massachusetts Institute of Technology in 1907 and taught there for three years. He then spent four years at Bowdoin and in 1920 joined the Northeastern faculty.

THOMAS H. WHITE, who retired in 1923 from his post as chief engineer of the Canadian Northern Ry. lines and who was active in the early construction of the Canadian Pacific and Canadian National railways, died recently in Vancouver at the age of 92.

JOSEPH A. SARGENT, assistant project engineer on the Lincoln tunnel and supervising engineer on the tunnel for PWA until a heart ailment recently forced him to curtail his activities, died Apr. 20 in New York City at the age of 66. Sargent was a graduate of the University of Nebraska. He was for a time division engineer on the Mexican Central Ry. and later became an engineer for the U. S. Reclamation Service. In 1906 he became assistant engineer on construction of the East River subway tunnels in New York City and then, after five years private practice, became chief engineer in 1913 of the Ebro Irrigation & Power Co. in Spain. He served overseas with the engineer corps, receiving the Croix de Guerre. After the war he worked on various South American and European irrigation, railroad and power projects. For the past few years he had been active for PWA on New York City tunnel projects.

QUINCY A. CAMPBELL, 47, assistant chief engineer of the National Paving Brick Association, died in Cleveland, April 19. Campbell was a graduate of Ohio State University in 1920. He joined the Ohio highway department in 1921 as assistant engineer, rising to the rank of assistant chief engineer of maintenance in 1928 when he resigned to join the Paving Brick Association.

IRVIN ALLRED, 58, county surveyor of Power County, Idaho, and engineer in charge of Power County road district No. 1, was killed in an automobile accident Apr. 11.

EDMUND C. MILLER, assistant engineer for the state department of public service of Washington, died Apr. 7 in Olympia at the age of 47.

OLIVER H. HORNER, Kansas City civil engineer who practiced as a member of the firm of Horner & Wyatt, died in Kansas City Apr. 13 at the age of 51.

WALTER S. STANLEY, 47, city sanitary engineer of San Antonio, Tex., died there Apr. 11.

FRANK E. WARREN, construction manager for the George A. Fuller Co. of New York City, died Apr. 20 at the age of 55. At the time of his death he was in charge of work on the superstructure of the Red Hook housing project in Brooklyn. Warren joined the Fuller Co. immediately after his graduation from the University of Illinois in 1905.

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Extra Time Allowed On Wyoming Bridge Job

In our account of a Wyoming district court's decision refusing to award more payment for extra work than had been provided for in a supplementary agreement between the Omaha Steel Works and the Wyoming highway department (*ENR*, Apr. 13, 1939, p. 36), it was incorrectly stated that a penalty had been charged against the contractor for the full time by which he exceeded the original contract.

When the extra work agreement was drawn up, the contractor was allowed an extension of 24 days. The penalty was charged for the 46 days by which he exceeded the new limit.

Lincoln Elect. Co. photo

CLEVELAND BRIDGE NEARS COMPLETION

WORKMAN are welding the steel floor grating for Cleveland's $7,000,000 Main Ave. Bridge, scheduled to open June 30; the floor grating is laid in panels arc welded together. Two 120-ft. approach spans are of all-welded construction.

The new bridge, 7,400 ft. long including approaches, contains ten main spans varying in length from 200 to 400 ft. with a total length of 2,520 ft. The bridge has six traffic lanes separated by a center curbing. It contains 15,000 tons of steel.

Built by Cuyahoga County with the aid of a PWA grant, the bridge will form a link in the proposed 16-mile lakefront drive project.

Battery Bridge Opposed By Building Congress

The proposed bridge across New York harbor connecting the Battery in Manhattan with Brooklyn is opposed in a resolution adopted Apr. 18 by the board of governors of the New York Building Congress. The bridge plan is being pushed by the Triborough Bridge Authority and has been authorized by the New York City government and the state legislature.

In opposing the project, the congress held that alternate proposals to link lower Manhattan and Brooklyn have not been given adequate study, that the bridge would create a difficult traffic problem as well as injure the appearance of lower Manhattan, and that it would be a navigation hazard. Pointing out that its action did not imply approval of the plan for a tunnel at the same site, the congress said that it was studying the proposal of the Regional Plan Association that Brooklyn Bridge and its approaches be improved to carry additional traffic.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week total $48,297,000, a 38 per cent increase over the corresponding week last year, but 10 per cent below last week. This is the sixth consecutive week in which current awards have exceeded their respective 1938 values.

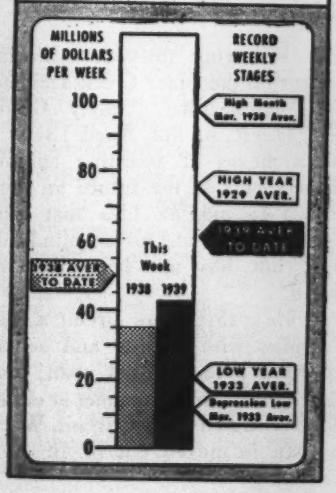
The week's volume brings the 1939 total to $1,041,837,000, a 23 per cent gain over the $848,059,000 reported for the initial 17-week period last year.

Private awards for the current week are 2 per cent higher than a year ago and 56 per cent above the preceding week. Public construction tops last year by 64 per cent, but is 25 per cent lower than last week.

In the classified construction groups, waterworks, sewerage, bridges, public buildings, earthwork and drainage, and unclassified construction report gains over the 1938 week, and commercial building and large-scale housing, and unclassified construction top their volumes of a week ago.

New capital for construction purposes for the week totals $67,718,000, an increase of 24 per cent over the volume for the corresponding week last year. The week's financing is made up of $28,716,000 in state and municipal bonds, $37,700,000 in federal appropriations for WPA construction, and $1,302,000 in corporate security issues. The $20,000,000 New York bond issue for the state institutional building and grade crossing elimination programs is primarily responsible for the second highest weekly state and municipal total of the year.

New construction financing for the year to date, $668,657,000, is 29 per cent above the volume for the initial 17-week period in 1938.



CONTRACTS

(Thousands of dollars)

	Week Ending Apr. 28 1938	Apr. 20 1939	Apr. 27 1939
Federal	$1,043	$2,528	$3,512
State & Municipal	19,102	41,696	29,623
Total public	$20,145	$44,224	$33,135
Total private	14,875	9,723	15,162
TOTALS	$35,020	$53,947	$48,297

Cumulative
1939 ....(17 weeks)....$1,041,837
1938 ....(17 weeks).... $848,059

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 17 Wk.	1939 17 Wk.
NON-FEDERAL	$431,837	$357,457
Corporate securities	101,250	68,184
State & Mun. bonds	211,645	209,938
R.E.A. loans	.....	22,211
R.F.C. loans	63,420	234
P.W.A. allotments	2,029	.....
U.S.H.A. loans	53,493	56,890
FEDERAL	$86,532	$311,200
TOTAL CAPITAL	$518,369	$668,657

FHA MORTGAGES

	Week Ending Apr. 23 1938	Apr. 15 1939	Apr. 22 1939
Selected for appraisal	$22,995	$26,175	$25,576*

Cumulative
1939 .....(16 weeks)....$363,185*
1938 .....(17 weeks)....$245,307
*Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Apr.	234.86	112.90
Building Cost	Apr.	196.45	106.20
Volume	Mar.	210	92.

MEETINGS

BUILDING OFFICIALS CONFERENCE OF AMERICA, annual meeting, Book-Cadillac Hotel, Detroit, May 1-5.

AMERICAN ROAD BUILDERS ASSOCIATION, annual business meeting, Willard Hotel, Washington, May 24-25.

NATIONAL CONFERENCE ON STATE PARKS, annual meeting Itasca State Park, Minn., June 5-7.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 11–15.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Pennsylvania State College, State College, Pa., June 19-23.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 26-30.

REGIONAL AND LOCAL

AMERICAN WATER WORKS ASSOCIATION, section meetings: Indiana, Antlers Hotel, Indianapolis, Apr. 25–26; Florida, Alcazar Hotel, Miami, May 4–6.

AMERICAN SOCIETY OF CIVIL ENGINEERS, section meetings: Mid-South, Peabody Hotel, Memphis, May 5-6; Arizona, Pioneer Hotel, Tucson, May 13.

PACIFIC NORTHWEST REGIONAL PLANNING COMMISSION, annual conference, Olympic Hotel, Seattle, Apr. 27-29.

MARYLAND-DELAWARE WATER AND SEWERAGE ASSOCIATION, annual conference, Fort Cumberland Hotel, Cumberland, Md., May 4-5.

ANNUAL SURVEYORS CONFERENCE, Iowa State College, Ames, Ia., May 5.

EASTERN PHOTO-ELASTICITY CONFERENCE, Cornell University, Ithaca, N. Y., May 13.

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Minnesota Adopts State Civil Service

The Minnesota legislature last week adopted a state civil service law providing for entrance examinations, classification of positions, uniform salary plans, employee training, and systematized promotion and transfer based on service ratings. The law requires appointment of a state personnel director through competitive examinations open to residents outside of the state. More than 5,000 employees will be covered.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Norris Dam Deflection

Sir: In Fig. 2 of the article "Measuring Dam Behavior" (*ENR*, March 30, 1939, p. 440), the scale of deflection of Norris Dam is given in tenths of an inch, whereas this should be in hundredths of an inch. Thus, the maximum daily cycle amounts to about 0.03 in. instead of about 0.3 in.

The title of this article conveys the impression that I am connected with the Massachusetts Institute of Technology whereas I am on the engineering staff of the Tennessee Valley Authority.

DOUGLAS MCHENRY
Knoxville, Tenn.

Pollution Control

Sir: The article "Pollution Control—By Whom?" by Messrs. Glace and Browning (*ENR* Mar. 16, 1939, p. 380) is a timely one, especially in view of the various forms of federal legislation for pollution control. Basically, I believe the authors are correct in their conclusions that pollution control should be administered by a board composed of representatives other than entirely health agencies interested in pollution control. In this connection I speak from personal experiences with our own Illinois law, which in 1929 created a Sanitary Water Board composed of the directors of public works and buildings, conservation, agriculture, health and a fifth member representing the industries. The workability and results obtained from our Illinois law have convinced me that this is the proper approach to the solution of the pollution control problem.

Much criticism has been aimed at various state health departments for their apparent inability to control pollution, but in the majority of states it is necessary for the departments to show a so-called public health hazard and this is often extremely difficult. Thus, while I do agree with the authors' conclusions, there are several statements in it which, as a state sanitary engineer and chairman of the Conference of State Sanitary Engineers, I could not pass by without comment and challenge. I refer particularly to the following:

". . . This policy [administration of anti-pollution activities by state health departments] has resulted—generally speaking—either in no treatment because the state sanitary engineers are not convinced that money spent for sewage treatment will bring adequate returns in terms of protection of public health; or else in the installation of works designed to abate a visible nuisance with a degree of treatment insufficient properly to remove the undesirable condition.

"Because of the failure to recognize this basic change in environmental conditions there have been installed scores of so-called sewage treatment works which scarcely merit the name. The time is at hand to revise our standards on treatment and to be honest with our clients, the public. Let us advise them that adequate treatment is something more than screening and settling and that the fullest and best treatment is none too much for the average condition."

To one not thoroughly familiar with the types of treatment plants that have been installed, it might appear as though the various state sanitary engineers have allowed the installation of "scores of so-called sewage treatment works which scarcely merit the name." From my knowledge of the activities in the midwestern states I know that such a statement is not based on facts. I believe, therefore, that it is indeed unfortunate that a periodical with national distribution should make such an inference, especially in view of pending federal legislation which in several bills involves health departments as the key agency.

Our Illinois stream pollution policy, which I believe is similar to many of the other states in this area, has been to require a degree of treatment, in each instance based upon the particular outlet stream, the dilution afforded and its uses. This seems to me to be the only sensible and practical approach. In other words, to carry on in a stream as much of the natural purification as is possible without creating any conditions which would be detrimental to aquatic or fish life, recreation or public health and to agricultural pursuits or for any of the practical uses of the stream.

Some of these comments are perhaps based on personal experiences and opinions, and while I do not personally know the authors of this article it is apparent to me that they are not familiar with the pollution control picture as a whole and while their comments, as quoted above, may possibly apply to certain sections, I know that these comments do not apply to this section of the country. This prompted my comments on this article because I know of the wide circulation in all parts of this country that *Engineering News-Record* enjoys. I believe the only conclusion that could be reached of the broad statements made in a periodical of national circulation is that these statements were intended to convey the idea that state health departments throughout the country were allowing numerous "so-called treatment works" to be installed, which treatment works were allowing under-treatment or inadequate treatment with the result of objectionable stream conditions. I do want to repeat that I believe personally that it is unfortunate that such an impression was thus conveyed in a periodical of this calibre.

C. W. KLASSEN
Technical Secretary Sanitary Water Board
Springfield, Ill.

The statements by Messrs. Glace and Browning which Mr. Klassen refers to are their opinions. They were published in the interests of full and frank discussion of a subject of national importance, a question on which all informed parties should be permitted to express their views, whether or not they are in line with those held by this journal.—EDITOR.

Bridge Accidents

Sir: Referring to your editorial comment on the Clear Creek accident under the heading "Safety Guide Lines" (*ENR*, p. 482, April 13):

As a means of guarding against such accidents in the future an idea occurred to me, an idea that perhaps has also come to the minds of others, but has not been brought forward.

Provide a three-wire circuit across the bridge with a plug and socket connection between each span; one wire grounded with a magnet at either end in series in a closed circuit. When one span is moved out of line for

any reason and the road become dangerous, the electric lines are cleanly broken. The magnets then close a circuit which activates the other line from either end and operates a suitable danger alarm and light, set in parallel, on each span.

If this idea has already been brought out, don't file this, but use it to heat the building.

JOHN F. MILLER
Consulting Engineer, New York

Why Unit Price Bids?

Sir: In *Engineering News-Record*, March 16, 1939, appears an article by an anonymous engineer-contractor entitled "Why Unit Price Bids?" It is to be hoped that this article will be read by every reputable contractor and by every professional engineer. It provokes searching thoughts in the minds of honest engineers.

As a group, engineers have, in the past, been considered as professional to an extent and as honest to a much greater extent. During the last few years the leaders in the profession have been striving diligently to build up a more professional attitude on the part of engineers of all kinds. To this end the extension of licensing or registration systems has been urged; the requirements for licensing are being made more stringent each year; a period of interneship of at least four years is being required before recognition as a professional engineer. These steps are highly desirable and essential for the more complete protection of clients from incompetence on the part of professional practitioners.

The article referred to presents a much more serious problem for our consideration. The author sets out "negative benefits" and "positive evils" of unit price bidding, but the classification in each group appears to rest largely on the premise that the engineer is dishonest as well as incompetent. One must infer that this contractor's experience with designing engineers has been sad. Is this experience typical? Must a client, in order to protect his interests, require a bond of a professional engineer? Honest engineers—and with few exceptions engineers are honest—resent such an inference. It should not be, and is not, necessary to discard a fair and equitable method of bidding because in rare cases such a method may be abused.

The complaint that unit price bidding does not afford a fair method of computing the value of changes in the work appears to be based on the practice of "lumping" units of this character. Correct classification of units and true unit bidding results in positive, not negative, benefits.

The references to mistakes in computation and to deliberate unbalancing of bids shed no glory on contractors and are not pertinent to a comparison of methods as to bidding. No form of bidding will protect client or contractor from an unscrupulous engineer, and seldom does an unbalanced bid deceive the competent engineer. A properly prepared specification and a carefully drawn contract, let on the basis of unit price bids, insure equitable dealing and involve the smallest possible element of chance.

The practice of lump sum bidding, with stated unit prices for additions or deductions, is subject to abuses as great, if not greater, than those cited as objections to the unit price system. Seldom is extra work done at unit prices commensurate with those used by the contractor in computing the lump sum price involved in the main contract, even though there is little or no difference in character or cost to the contractor between the main work and the extra work. The evils of force account and extras are too well known to engineers who have supervised large construction jobs. Stronger, more logical and less insulting argument must be advanced before such engineers will be inclined to agree with this anonymous author.

P. L. HOLLAND
Chief Engineer, Maryland Public Service Commission, Baltimore, Md.

Open Grid Bridge Floors

Sir: In your editorial of March 30, 1939, on "Open Grid Bridge Decks" you say that:

". . . the first major installation of an open mesh floor was made only about six years ago on the bascule span of the University Bridge in Seattle."

This statement is misleading because it assumes and implies that there were other smaller installations of this type of bridge flooring preceding the one on the University Bridge. This is not so.

We developed this flooring some time before but J. A. Dunford, Seattle's bridge engineer was the first, in 1932, to specify its use on a bridge, and this was on the University Bridge. We had made no previous installations.

We would appreciate your publication of the fact that on the University Bridge in Seattle was made the *first* installation—not the first major installation of an open grid bridge deck.

WALTER E. IRVING
President, Irving Iron Works Co. Long Island City, N. Y.

Hydraulic-Feed Soil Sampler

Sir: Reference is made to the article entitled "Hydraulic-Feed Soil Sampler" appearing on page 48 of *Engineering News-Record*, March 30, 1939.

The second sentence in the article referred to above constitutes an unfortunate mis-statement. The drill rig in question was developed, not by the U. S. Waterways Experiment Station, but rather by independent manufacturers catering to the needs of the oil industry. The U. S. Waterways Experiment Station simply found that the rig, as so developed, serves very satisfactorily certain of the needs of the station's soil mechanics laboratory.

PAUL W. THOMPSON
1st Lieut., Corps of Engineers Director, U. S. Waterways Experiment Station, Vicksburg, Miss., April 11, 1939

Army Road Builders

Sir: Have just read with a great deal of interest the item on p. 77 of your March 2 issue of the award of an American Legion banner by your magazine to the 23rd Engineers Legion Post 820 at Chicago.

The writer had the honor of serving as a captain in this famous regiment under Col. E. N. Johnston from date of organization in October 1917 to July 1918, going to France with the first battalion, Major H. H. Stickney commanding, in January 1918. We were at once sent to the St. Mihiel sector to build roads with 1st and 26th divisions. We had some great experiences and truly the pick and shovel soon became our tools of trade.

CHARLES CROTTY
Asst. Director of the Port of Houston Houston, Tex.

ENGINEERING NEWS-RECORD

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APRIL 27, 1939

THE COST of construction depends upon the constructor's conception of how the various operations should be conducted and his estimate of the cost of the individual items making up the whole. While materials prices can be determined and labor rates figured in advance, the assembly of those materials into the finished construction product by labor whose production and efficiency are unknown factors makes construction costs an intangible and variable item. The constructor's conception of procedure determines the cost to the owner. His organization and construction ability—plus the breaks—determine his own costs. Though no two construction projects are identical and the general level of construction costs is the average of the cost of numerous projects of similar nature, this issue is largely devoted to the subject of costs to aid the reader in determining the present cost level. Tangible cost items are given in materials prices and labor rates; various conceptions of project costs are presented through a review of unit bid prices. Yet after all, this material can be taken only as a reference; there is no substitute for experience in estimating the cost of construction.

Dam Foundation

LOGICAL DAM SITES usually occur where foundation conditions are poorest. This statement, if questionable on the score of absolute accuracy, is becoming less questionable with the years. The majority of good dam sites have been utilized, the trend of the times is toward multiple-purpose dams whose location is fixed by other considerations than a power drop, and flood control and navigation often require dams where much geologic and weathering action has taken place. Papers on dam design and construction at last week's A.S.C.E. meeting in Chattanooga emphasized the foundation problem. Most of the TVA dams, as well as many dams elsewhere, are founded on seamed or cavernous rock, and foundation preparation by grouting and filling has been a major task. This situation makes the engineering geologist increasingly important and places the art of grouting at the top of the list of subjects requiring research and careful recording of experience.

Grouting Lessons

GROUTING reached a virtual peak of concentration of injection points in the operation of solidifying the cavernous limestone foundations for Chickamauga Dam. With only 9½ in. of rock between grout holes in this operation, a good claim for a record seems established. But the work as described on a following page carries more important lessons, and among them the emphatic warning against economy in exploratory drilling. At Chickamauga lady luck showed her hand to perfection in the location of the widely spaced drill holes so as to miss every cavernous area in the foundation rock. Chance is a formidable enemy in exploratory drilling. More novel information from the Chickamauga operations is, however, that bentonite mixed with cement-sand grout performs a most helpful task by increasing the penetration of the mixture and reducing the wear on the grout pumps.

Better Highways

MAINTENANCE of highways is not as spectacular a task as construction but it is a larger and more important one in the long run. The employment created is greater and more permanent; more equipment and materials are purchased than for new road construction. But it is by their contact with the public, and what this means to both constructors and maintenance men, that the maintenance divisions of our state highway departments make their major contribution to the future of highway work. The men in charge of road upkeep build public good-will, and it is public good-will that backs road improvement and checks legislative inroads on highway funds. Hence the importance of the series of articles on highway maintenance operations beginning in this issue. They are not manuals of maintenance practices, but they can stimulate the maintenance men themselves to a higher appreciation of their position as contact men with the thirty million highway users.

A New Record

WITH NEARLY $100,000,000 income from road users' taxes in sight for 1939, a budget pruning committee of the New York legislature proposes to spend $17,691,000 in state highway construction

and maintenance. This establishes a peak in diversion that makes the takings of Governor Lehman look small—although his record for the last half decade is close to a quarter of a billion dollars. That even the governor's budget allowance of $27,000,000 would be woefully inadequate is clear to everyone who knows New York road conditions outside a few parkway systems. The further curtailment to $17,691,000 means that construction expenditures are cut to $6,933,000, which (after matching the year's federal-aid allotment of $5,573,000) leaves less than a million and a half for all other construction. Not long ago the state highway commissioner said that $300,000,000 would be required for reasonable modernization; three years' honest use of the improvement tax collected from road users could accomplish the modernization.

The Fort Peck Finding

AFTER FIVE MONTHS' STUDY backed by elaborate ground explorations and analyses the Fort Peck investigating board has brought in a reassuring verdict. The great slide which wrecked the dam last September, while revealing serious weaknesses, does not necessitate abandonment of the structure but can be repaired by rebuilding with flattened slopes.

The verdict is reassuring because the dimensions and circumstances of the slide rank it among the memorable engineering accidents of recent decades. It would be tragic if the failure had been found chargeable to some basic lack in knowledge or skill. The huge earth embankment, largest ever undertaken, had been built with all the aid of modern soil-study procedure. The verdict vindicates this course by approving of the embankment as such; failure was due, says the board, to weakness of the foundation strata, a weakness which the soil studies apparently had failed to discover.

That the structure of the dam above its foundation, core as well as enclosing shell, showed great firmness in the saturated parts adjacent to the destroyed section proves that the hydraulic filling process produced a strong dam. For this reason it is hard to reconcile the utter destruction of a 2,000-ft. length of the dam with the stability of the adjacent embankment otherwise than on the score of foundation weakness. Both majority and minority reports, though they differ in analysis of detail actions, conclude that such weakness did exist. The reconstruction measures therefore are so planned as to eliminate the effect of this weakness.

Unfortunately the board's report says nothing more about causes than two sentences, without detail or indication of reasons. A multitude of questions is left unanswered. Not even the results of the exploration borings are cited. Little light is thrown on the failure. Because of its great importance and the vital need for thorough clarification, it is to be hoped that the case will not rest thus unsatisfactorily. To the engineering profession the slide is one of the experiences and lessons by which practice should be more surely guided. Engineers will need to have all conditions and actions involved made thoroughly clear in order that the full teachings of the accident will be available for future use.

Simplified Valuation

IN ITS DECISION in the Pennsylvania Public Utility Commission case (*ENR* April 20, p. 525) the U. S. Supreme Court has clarified some of its earlier decisions with respect to public utility rates, and gives clear indication that it seeks to simplify valuation work without completely discarding the system built up during forty years around the famous *Smyth vs. Ames* case.

That case has long been held to require that in placing a value on utility property for rate-making purposes the value must be based not only on what the property cost originally but on what it would cost to reproduce. But a careful reading of Supreme Court decisions of recent years will show that the court has been slowly departing from this original concept. Now, in the Pennsylvania utility commission decision, it states more clearly than heretofore that so long as a regulatory commission *considers* these elements of value it need give no weight to them in its final decision. Thus these two elements are relegated to an unimportant position.

If original cost and reproduction cost no longer have controlling weight in valuation work, the way is cleared for a simple determination of what the property of a utility is worth at the time it is being valued. This appears possible through basing value on the cost of a modern plant of equivalent capacity rather than on a detailed appraisal of the existing plant. Such a method would preserve the increments of value that should accrue to the owners of serviceable plants yet it would work toward the faster replacement of outmoded plant and equipment.

Simplification of rate making is badly needed. The Supreme Court has advanced such simplification by its latest rate decision.

POWER CANALS FOR THE TRI-COUNTY PROJECT CUT THROUGH DEEP RIDGES OF LOESS MATERIAL.

Water Power in Nebraska

V. T. BOUGHTON

Managing Editor, Engineering News-Record

Contents in Brief — For the past five years Nebraska has been engaged in building a group of combined power and irrigation projects that has been widely characterized as "a little TVA" having no economic justification. The general character of those projects is given in the following article, the acute water question is discussed, and the present indications as to power markets are outlined as the result of a first-hand study of the two projects now in operation and the project now under construction. A subsequent article will take up the engineering and construction problems of the three projects.

FIVE YEARS AGO Nebraska began the public development of the state's water power resources with money from the Public Works Administration in the form of loans and grants. To date the federal government has made commitments totaling about $60,000,000 to three public power and irrigation districts having water power development as a major part of their programs. These are the Platte Valley Public Power and Irrigation District, the Central Nebraska Public Power and Irrigation District and the Loup River Public Power District. Local people have contributed about $200,000 for promotional work in these districts.

Widely characterized as Nebraska's "little TVA," these public power and irrigation projects have been the subject of much adverse comment by those who are opposed to their construction. Total costs have been declared to be so high as to put the unit cost of power and irrigation water beyond reason; question has been raised as to whether any considerable amount of firm power can be produced because of the uncertainty of the water supply; power markets have been declared to be lacking, and the operating difficulties of the two completed projects have been held up as evidence of the impracticability of the undertakings. As a consequence, unbiased information concerning the undertaking is hard to obtain.

Opposition to the projects is both local and national. Locally, the opposition is due chiefly to factors peculiar to the region in which the projects are being built. In the first place, water in Nebraska is a valuable commodity which is jealously guarded by those who need it to irrigate their lands. People on existing irrigation projects who have seen the Platte River go dry and their crops burn up are violently opposed to further drafts for any new combined power and irrigation project. Quite naturally, the privately owned power companies are opposed to the projects, but it is rather surprising to find the power companies supported by town officials in communities having municipally owned power plants. The reason for this is found in the fact that the relatively high rates charged by these plants bring in a tidy income which carries a large part of the municipal expenses, and the town officials see in the public power districts a move to confine surpluses to a general reduction in domestic rates.

But for engineers the Nebraska undertakings hold out much wider

interest than those that lie in the controversial subject of public versus private power development. First, there are completed or under construction three hydro-electric power undertakings that are unique both as to design and as to cost of construction; and second, there are questions of water conservation and use which are important for all concerned with development of the water resources of the arid regions of the West. To date, three diversion dams and two reservoirs have been built, 88 miles of power canals have been dug, and three power plants of moderate size have been put into operation. Now under construction is the nation's second largest earthfill dam, a fourth diversion dam, 67 miles of power supply canals, three more power plants, 102 miles of main irrigation canals and 540 miles of small laterals.

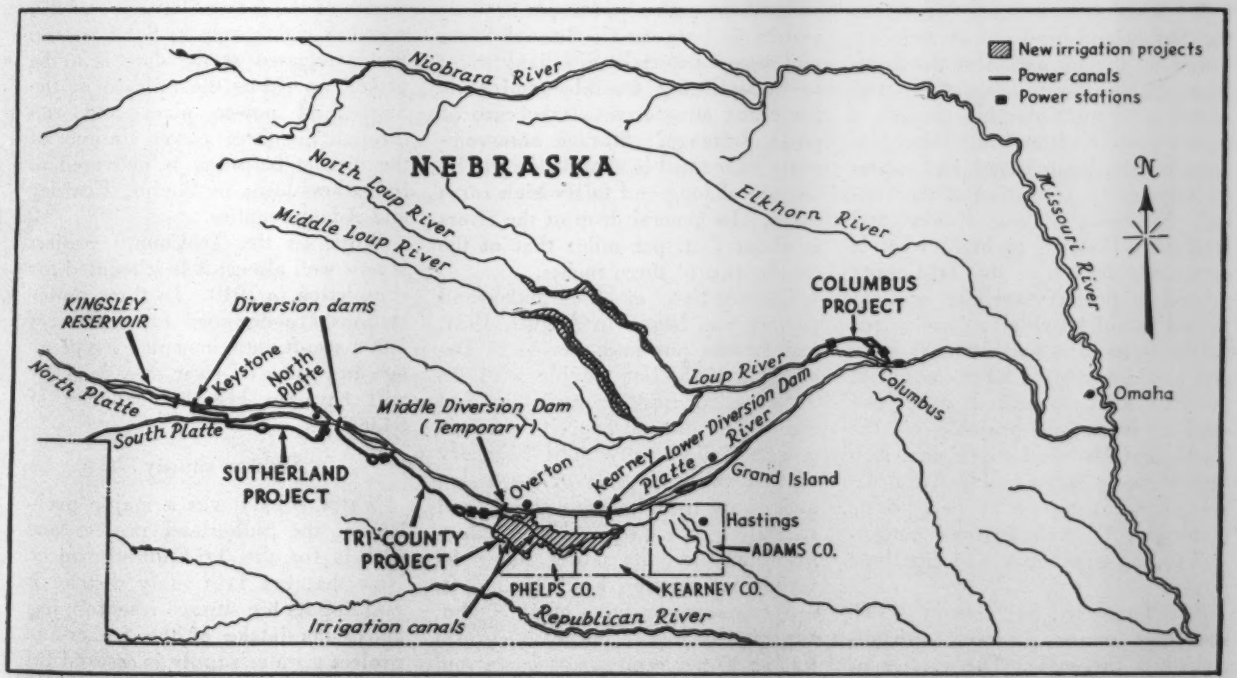
Power aids irrigation

Nebraska's climate ranges from subhumid along the eastern edge to semi-arid in the West, with a wide central area where there is insufficient rainfall for crop production. Dry farming has been practiced extensively in this area, a large section of it having been put under cultivation in the war days when wheat prices were high, but there is evidence everywhere that the record has been one of frequent crop failure especially in the recent dry years.

Irrigation of land in the wide flat valley of the Platte River was begun in a small way as far back as 1866 and has gradually expanded to include about 200,000 acres now under irrigation canals. But the flow of the Platte River is so uncertain in the central part of the state that these bottom lands have not always been able to obtain from direct flow as much water as they needed, and stored water has not been available. Lands at higher elevations never have been reached, and yet they need little water in normal years to make them suitable for a wide variety of crops. Rainfall in Phelps, Kearney, and Adams counties, where the lands now being irrigated lie, averages 24 in. per year, while 36 in. is needed to carry crops to maturity. Hence the irrigation system is designed to supply 12 in. per acre, or about 200,000 acre-ft. for the work now in hand, which combines storage with use of any available direct flow.

Schemes for providing irrigation water for the fertile lands lying south of the Platte River in the central part of the state have been actively promoted for many years, but as the low flow of the North Platte River—the principal source of water for the south-central area—is over-appropriated, these schemes were largely based on storage and use of flood waters which come down both the North and South Platte in large quantities every Spring. Storage, however, was difficult to obtain. Because the river bottoms are wide and the underlying material porous, the construction of on-river reservoirs long appeared too costly. On the other hand, the off-river storage sites were neither large nor numerous, and the amount that can be diverted into them during the short flood season is limited by the amount that can be carried through long supply canals. Some of these studies of off-river sites indicated that power could be developed in bringing water down into the valley from storage reservoirs in the hills, but in all cases costs appeared prohibitive.

This was the situation when, in 1933, the National Recovery Act was passed, and it soon became evident that liberal federal aid would be available to foster construction of projects that could not be financed if required to repay their full cost out of earnings. The same year the Nebraska legislature passed an act providing for the establishment of



Two of Nebraska's public power undertakings are in operation, the Sutherland and Columbus projects, and the Tri-County project is under construction. Irrigation of 220,000 acres is included in the latter. Two small projects on branches of the Loup River each irrigate 30,000 acres. They develop no power.

The Columbus plant of the Loup River Power District was the first to go into commercial production.

public power and irrigation districts and authorizing the district to borrow money from the Public Works Administration on loans secured by the potential earnings of the district.

Power districts formed

Among the first power districts to be organized was the Platte Valley Power and Irrigation District to build what is commonly known as the Sutherland project. It was followed by the formation of the Loup River Public Power District for construction of the Columbus project, a power project without irrigation features on the Loup River, and subsequently by the formation of the Central Nebraska Public Power and Irrigation District, to build what is commonly known as the Tri-County project, a project that then was expected would be able to supply irrigation water to about 500,000 acres and would develop a large amount of power. Also organized were two smaller irrigation projects on the North and Middle Loup rivers. Neither of these latter included the development of power as part of its undertaking but both were authorized to buy or generate and distribute power.

The basic scheme around which the three major projects were designed is the same. The valleys of all the rivers in central Nebraska are wide and flat and are flanked with low hills of loess or fine sandy material. The valley slopes are gentle and the only way in which heads for power development can be obtained is through the use of long canals leading water out of the bottomlands into the hills and then carrying it downstream many miles to some point where the river swings close enough to the hills to permit the water to be returned to the river channel through a power plant. This results in long canals through loess and sandy material—too many miles to make lining feasible—and calls for many structures to take care of cross drainage. Storage reservoirs must be formed in shallow basins by the use of long and fairly high earth dikes. The general drop of the rivers is about 7 ft. per mile; that of the canals, two to three inches.

Construction of the Sutherland project was begun in August, 1934, and it was put into service in December, 1935, but trouble with ice developed almost immediately and the project did not begin to produce power commercially until February of this year. Details of its design and of its troubles with canals and structures will be given in a subsequent article. Its power plant develops an average head of 204 ft. and contains two units of 18,000-hp. capacity having an output of 13,000 kw. at 90 per cent power factor and using 900 sec.-ft. of water.

The water used by the Sutherland project belongs to irrigators below the tailrace of its power plant. Flood waters stored in Sutherland reservoir are to be sold to those irrigators to help pay for the project.

Construction of the Columbus project was begun early in 1935. The Loup River on which it is built has a much more uniform flow than the Platte, hence water supply was not a major question, but a most difficult problem was presented by the fact that the river carries a large quantity of silt. The silt problem will be taken up in the subsequent article.

The Columbus project has two power stations designed to use a uniform draft up to 3,000 sec.-ft. supplemented by pondage for peak loads. The Monroe station contains three 3,200-hp. units developing a head of 32 ft., and the Columbus station has three 18,000-hp. units developing a normal head of 112 ft. The system has been in operation since September, 1938.

Work on the Tri-County project of the Central Nebraska Power and Irrigation District was begun in the spring of 1936 but active construction was held up for many months by legal questions. The project differs from the other two in that it includes construction of a reservoir of 2,000,000-acre-ft. capacity near Keystone above the intake of the Sutherland project for the storage of flood waters of the North Platte. The district has rights only to flood waters. Water released at the dam is to be picked up below the tailrace of the Sutherland power plant and run through the three power stations of the district before it is delivered to irrigators down in Phelps, Kearney and Adam counties.

Work on the Tri-County project is now well along; it is scheduled for completion in 1940. Its three power stations are designed for a flow of 1,800 sec.-ft. supplemented by pondage and some off-river storage. They will have an installed capacity of 54,000 kw.

Water supply

Water supply was a major problem of the Sutherland project and still is for the Tri-County project. Now that the Tri-County district is building its big storage reservoir just above the intake of the Sutherland project a water supply is assured for the irrigators whose water the district uses for power development because they have first claim to enough

water to meet their authorized appropriations. And while there is no question but that the storage of 2,000,000 acre-ft. behind Kingsley Dam (formerly called Keystone) would meet both the needs of these and other power appropriations and would still leave ample to irrigate the lands under the canals of the Tri-County project there is question as to whether there are enough flood waters in the North Platte River to fill such a reservoir and keep it replenished annually. Studies of records for the past 20 years indicate that such a reservoir would have been filled to overflowing in all but four years. Current studies show that from Oct. 1 of last year to March 1 of this year, 584,700 acre-ft. passed the gaging station at Overton, Neb. Of this amount, 150,000 acre-ft. would have been released to meet the needs of the water power plant at Kearney leaving 434,000 acre-ft. that could have been stored in five months, with the period of melting snow yet to come.

A major cause for uncertainty arises from the fact that the U. S. Reclamation Bureau is now beginning to store water behind Seminoe Dam for the irrigation of 66,000 acres in the Kendricks project near Casper, Wyo. The Seminoe reservoir has a capacity of 1,070,000 acre-ft. What effect this storage will have on the flow of the North Platte is unknown, as the flow in central Nebraska will depend in some part upon the return flow from the irrigated land in the Kendricks project. Officials of the Tri-County projects hold that their rights to the waters of the North Platte are superior to those of the Kendricks project.

On the other hand, a favorable factor in the water-supply situation will be the start of the diversion of water from the headwaters of the Colorado into the headwaters of the South Platte River as planned for the Colorado-Big Thomson project now under construction in Colorado. This diversion should add to the low flow of the South Platte River, aiding the irrigators below the confluence of the South and North Platte and so making possible the storage of more water in the Kingsley reservoir.

Another factor favorable to the success of the present undertaking is a finding by the Nebraska Supreme Court to the effect that the Central Nebraska District may not take water out of the Platte River Valley for the irrigation of lands lying over in the Republican River watershed, as was proposed when the district was organized. This reduces the land under the Tri-County irrigation canals from 500,000 acres to 220,000 and materially reduces the amount of water that will have to be drawn from the Keystone reservoir. Thus the carryover will help to offset any shortage in dry years.

Sutherland power

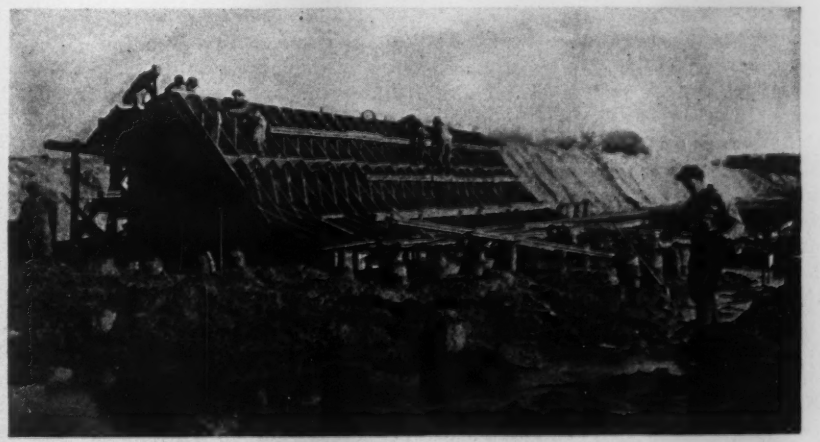
The Sutherland project began commercial sale of power in February of this year and since March 1 the average daily output has been 115,000 kw.-hr., the peak being about 70 per cent of the capacity of one of the two generators in the power station. Power goes to local private power companies, to municipalities and to other public power districts. This load is about 40 per cent of the designed capacity. Within a few weeks the contractors at Kingsley Dam will begin hydraulic fill operation, which, when the dredges are up to capacity, will require about 240,000 kw.-hr. per day. That work will continue until September, 1940, and by 1941 the district officials believe that they will have built up a sufficient market to take over that power.

The total amount advanced by the PWA in the form of loans and grants is $11,226,000, of which a considerable sum is still available for working capital during the load-building period. About $700,000 annually is required to pay interest, amortize the loan and operate the plant. Of this, $100,000 will come from water users as soon as water can be stored in Sutherland reservoir. The power output of the system should be about 100,000,000 kw.-hr. annually. Deducting line losses, this power can be sold for about seven-and-a-half mills per kw.-hr. and yet produce enough income to provide the remaining $600,000.

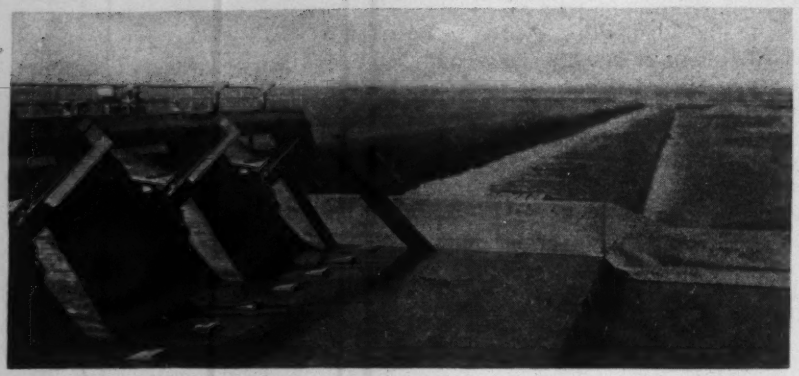
Loup River power

Last year the two power stations of the Columbus project produced 46,000,000 kw.-hr. as against 188,000,000 kw.-hr. estimated as the average annual output of the project. It is expected that the output will be up to about 90,000,000 kw.-hr. by the end of this year.

The district has $9,000,000 in bonds outstanding. Interest, amortization and operating cost amount to about $870,000 per year, which means that the average income from the power should be four and one-half or five mills. The district has had an offer of five mills from private power companies for all the power it can produce, but its officers believe that one of their functions is to build up the local use of power, especially in the rural areas. Consequently, the district is doing all it can to help the local districts of the Rural Electrification Administration, of which there are now twenty-eight in the state. At the present time 2,500,000 kw.-hr. of the Columbus output is going to the REA districts throughout the state, power being sold to the various districts at 1¢ per kw.-hr. average. The Loup district has 378 miles of rural line built



Diversion weir across the Platte River below North Platte for the Tri-County power and irrigation project.



Water for the Sutherland project is diverted at this weir. Gates in the foreground are used to sluice silt from in front of the canal intake.

and contracts let for 170 miles more. Lines are built where an average of 2.2 customers per mile can be obtained. Of the 830 customers already signed up 305 are connected to the system. Average sales were 66.3 kw.-hr. to purely rural customers in January.

Tri-County power

A study of the flow of the Platte River between 1895 and 1909 shows that there was sufficient water, supplemented by storage in the Kingsley reservoir, to have operated the three power plants of the district at 100 per cent capacity factor for the whole period. From 1910 to 1916 an average of about 90 per cent could have been maintained; from 1917 to 1931, 100 per cent capacity factor would have been possible, and from 1931 to the end of 1937 a reduction to about 50 per cent capacity factor would have been necessary due to the long drought. The average annual generation of the district over the 43½-year period studied would have been 353,368,000 kw.-hr. These figures are based on assumed evaporation losses from the reservoir 25 per cent higher than available data would indicate will occur, and on the assumption that the reservoirs and canals are full at all times. Losses from the canals which were being seasoned last year were somewhat less than one-tenth of one per cent per mile, which is lower than the loss figure used in this study.

Under normal conditions there is a considerable increase in the flow of the river between the site of Kingsley Dam and the diversion dam just below North Platte. This pick-up amounts to 1,500 sec.-ft. during the non-irrigation months, and to 2,500 sec.-ft. during the irrigation months, but these figures were reduced by 50 per cent in making the flow studies. Due to the conformation of the river valley, seepage losses from the Kingsley reservoir are expected to reappear downstream.

With the bonded indebtedness of the district being $19,793,000, 40 per cent of which is charged to irrigation and 60 per cent to power, and with annual power operating costs estimated at $196,000, the district expects to be able to sell its power at seven mills per kw.-hr.

Power interchange

Negotiations are now nearing completion for an interchange of power between the Platte Valley project, the Loup project and the Tri-County project, by which it is hoped to be able to make the most advantageous use of the water resources of the three districts. Upon completion of Kingsley Dam it will be possible to about double the firm power of the Sutherland system by diverting water for the Tri-County project through its canals and power station. But without this added water, the Sutherland project is expected to be up to its designed capacity by 1942. Officers of the Loup River Public Power District estimate that upon completion of the pending agreement for the interchange of power with the other two power districts they will be able to build up their load to a paying basis by 1943.

If a projected plan for setting up a state-wide public power system through the purchase of existing privately owned power companies by the public power districts is consummated, the Loup district should be on a paying basis by 1942. Late last year it looked as though the state-wide scheme would soon be an accomplished fact, but uncertainty as to what the state legislature will do has postponed further action until it adjourns.

Economic justification

From the economic angle, it would probably be easy to show that for the total investment—including both PWA grants and loans—these projects never can pay on a purely bookkeeping basis. But it must be recognized that they were undertaken as part of the nation's great program of creating employment through the construction of useful projects, and that as such they have created a large amount of continuous employment for a great many people. And having been carried out by normal methods as undertakings of the public power districts, the work being let out by contract under the supervision of regular engineering forces, rather than as relief operations, the employment created has been altogether normal in character. And one cannot traverse the area in which this work has been carried out without seeing on every hand the evidence of intangible benefits which cannot be easily evaluated on a dollars and cents basis.

Charging off the PWA grants against the intangibles, there is substantial evidence that income from the power developments and from the sale of irrigation water will repay the loans from the federal government. And it should be noted that the government subsidies do not bring the power costs down to the point where the public power districts can take business away from the private companies by undercutting their rates; the success of the public power development schemes appears to rest on the ability of the districts to build new business.

Looking upon these Nebraska projects as pioneering attempts to promote and coordinate the development of natural resources as public undertakings, little can be found to criticize and much will be found to commend. Though fostered by federal aid, their major virtue lies in the fact that they are essentially local in character; unmistakable evidence of the willingness on the part of local people to risk something in the development of the region in which they live.

Corewall Grouting At Chickamauga Dam

Contents in Brief—Grouting plan for south earth wing-dam of Chickamauga Dam; notes on experience with several types of grouting agents and details of heavy grout pump built on the work, condensed from a report by James B. Hayes, construction engineer.

BAD ROCK at the site of Chickamauga Dam of the Tennessee Valley Authority (*ENR*, Oct. 21, 1937) necessitated extensive grouting operations under most parts of the dam structure. Some of the most interesting of this grouting work developed in building the corewall for the flanking earth dam on the south, which extends across the flood plain for 2,800 ft. Here under 40 to 50 ft. of an overburden of about 20 ft. of good sandy-clay loam changing to a mixed sand gravel, limestone slabs and clay, is a fissured and cavernous limestone.

Several plans of consolidating the overburden and rock were studied and various grouting tests were made. As a final result, due to the high cost and the uncertainty of grouting through the overburden, it was decided that an open trench with grouting direct from the rock surface, would be used. As carried out the procedure was as follows:

With the rock surface cleaned off, a line of holes on 4-ft. centers and 40 ft. deep was drilled on the center line of the trench. The washing and grouting of these holes was followed by drilling, washing and grouting holes midway between those of the first set. If cavities were encountered, additional holes were drilled to outline the extent of the opening; these holes were then grouted without washing. If the depth was relatively shallow, the cavity was excavated the full width of the trench. The drilling and grouting process described was repeated until the holes were finally on 12-in. centers and in a few instances, additional holes were drilled and grouted. There remained only a 9½-in. width of rock between the final holes. If a cavity encountered was deep, 36-in. holes were drilled on about 10-ft. centers to the cavity, which was cleaned out along the axis of the dam and backfilled with concrete. Grouting was then completed in the usual manner. After all grouting had been done, a concrete cut-off wall 5 ft. high and well dowelled into the rock was constructed, and the trench was backfilled with selected material.

Water and cavern troubles

When work was started on the south earth dam, two groups of deep, partly-open cavities and an area of large boulders and gravel were encountered. A volume of water reaching a maximum of 15,000 g.p.m. flowed into the trench, interfering greatly with the work. Only one of the four original exploration holes (spaced on 100-ft. centers) had indicated cavities.

Holes were drilled intercepting the flow upstream from the trench, and grouting with asphalt, pitch, and sand-cement-bentonite-sawdust mixes was tried. None of these materials was successful, although large quantities were used and there was a very small leakage of materials into the trench. The water was finally taken care of by drilling two 36-in. holes along the upstream side of the bottom of the trench and by digging one 48-in. hole on the bank in which large propeller-type pumps were installed. In addition, two large pumps were used in the trench cut.

As a result of this experience, it was decided to drill new exploratory holes along the center line of the cut-off trench, between the original ones, bringing the spacing down to 25 ft. This brought out the fact that nearly all of the original holes on 100 ft. centers had missed the bad areas. Where cavities were indicated more holes were put down fully to explore them. One cavity was found nearly 90 ft. below the normal river surface

Fig. 1. Fissured and cavernous limestone under the south wing embankment of Chickamauga Dam required one of the major grouting operations of recent times.

and another 60 ft. below. Several smaller cavities were also located. These cavities were solution channels that crossed the axis of the dam at angles of from 30 deg. to 45 deg. with the axis.

To avoid the excessive inflow of water during excavation of the trench, preliminary drilling and grouting was done ahead of excavation on lines parallel to, and 30 to 40 ft. from, the center line of the trench in all bad sections. A low cost grout consisting of bentonite, cement and sand in the proportions of 1, 3, 4 was used in this work. That this method was successful was proved by the fact that in the next two cavernous sections opened up, the quantity of water pumped was very low, being about 40 g.p.m. in the first and 60 g.p.m. in the second.

After the cavities were cleaned out and concreted, connections were made to any possible unfilled sections of the cavity under the dam either directly by means of pipes or by drilling, and these sections were grouted with the low-cost grout after the trench had been backfilled with an impervious rolled fill. This was done to prevent subsequent settlement or sinks in the earth dam or its foundation.

Grouting methods and equipment

The consistency of grout used was varied, depending on the rate at which grout was taken, from 0.60 to 3 or 4 water-cement ratio (by volume). The grout nipple was sealed into the hole by lead wool or oakum and cement, and a pressure gage was placed at the hole. The return system of injection was used so that a free circulation could be maintained in the grout feeder line when the hole began to slow up. With two valves, one at the hole and one on the return line at the hole, the operator could regulate the pressure with a constant pumping rate.

The grouting unit (Fig. 2) consisted of a special mixer, a water meter indicating cubic feet or fractions thereof, a pump with agitator blades and two pressure pumps, all mounted on one frame with skids for convenient moving. The outfit was piped and arranged so that either or both of the pumps could be used and operation switched from one to the other without stopping the flow of grout. This equipment, except for the pumps and air-drill motors used for operating the mixer and agitator, was made in the works shop.

The pumps were 7 x 3 x 10-in. duplex piston type, driven by compressed air. Medium rubber valve facings were used, as well as special rubber pistons, case-hardened piston rods and specially treated cylinder liners. This unit gave excellent service. When moving to a new location, one connection for air, one for water and two for grout were made and the plant was ready to run.

Experience with grouting mixtures

It was found that bentonite used with cement increases the volume and acts as a dispersion agent. Used with sand, it carries that material in suspension and coats each grain so that it can be handled through grout pumps with very little wear. The combined mix forms a low-cost bulk that is quite satisfactory as long as it remains moist; it forms a dense water-tight material but shrinks and slacks when dried out in air. Bentonite used alone forms a thick gelatinous mass and in large quantities would cause the over-burden material to become unstable. Large caves filled with it would settle under pressure, hence the addition of cement and sand.

Several different mixtures were tried and used, varying from 3 cu.ft. of cement, plus 3 cu.ft. of bentonite and 3 cu.ft. of sand to 1 cu.ft. of bentonite, 3 cu.ft. of cement and 4 cu.ft. of sand, all with 10 cu.ft. of water, and mixed in the order listed, water of course first. In preparing the mixture, it was found that bentonite should be introduced first into relatively clean water with the cement and sand added later. The first mentioned mix was used in the beginning and after experimenting with different proportions and sequence of introduction of materials the second mix was adopted. Both mixtures made the same volume of material, 19 cu.ft. of liquid, of a consistency about equal to a cement grout having a water-cement ratio of 1 by volume.

It may also be noted that grouting with asphalt and pitch was done to stop leaks under the cofferdam for the main dam, where running water eliminated the use of cement. A regular roofing kettle equipped with a gear or rotary pump was used for melting. Later small single-action piston pumps of about 1-in. diameter by 1-in. stroke driven by air-drill motors were used. Holes were drilled with a 6-in. shot drill and cased to rock. A steam line with a return was inserted in the hole. At first steam was used during the entire grouting operation but later was cut off and used only to start the hole and when pressure had developed. A vent was left to release steam generated by the hot asphalt and water. Asphalt and pitch grouting was done at a rate varying from 1 to 2 bbl. per hour. Pitch was tried due to its lower cost, heavier specific gravity and lower shrinkage. It seemed to be as effective as asphalt.

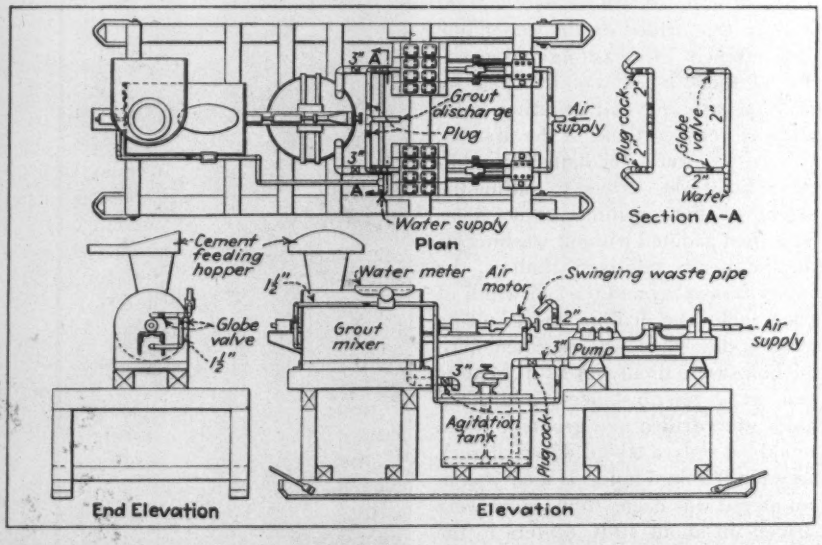


Fig. 2. High-pressure job-assembled grouting machine used at Chickamauga Dam; twin pumps insured continuous grouting in case mishap or servicing put one pump out of commission.

FIG. I. ONE OF THIRTY-FIVE COUNTY MAINTENANCE HEADQUARTERS BUILT IN PENNSYLVANIA.

Road Upkeep—A Big Public Business

C. S. HILL

Associate Editor, Engineering News-Record

***Contents in Brief**—The first of six articles that tell how the upkeep of our highway system is organized, what service it renders, what plant and man-power are employed, what tasks are involved and how money spent is audited and checked. This article gives a picture of the magnitude of highway maintenance, taking Pennsylvania as an example. As a group, the articles will show how important the maintenance departments are in developing and holding the goodwill of highway users.*

ROAD UPKEEP, although it vitally affects our daily life, is a public-works activity about which the average road user has a very vague understanding. Even the engineer not actually engaged in highway work is not well informed. Few know the size of the business, how it is organized, what plant and manpower it employs or how its expenditures are controlled.

Thus it is apparent that wider knowledge of how our highway departments function is of value not only that engineers generally may appreciate the magnitude of these operations, but also that engineers within all our highway departments may be better able to improve their public relations for it is through the road maintenance divisions that our state highway departments have their major contact with the public.

To get material for an adequate exposition of highway maintenance, the states of Pennsylvania, Ohio, Indiana and Illinois were visited. This article sketches the broad picture, using Pennsylvania as the example. Subsequent articles will take up the major functions of maintenance; the housekeeping job, auditing, providing recreational facilities for road users, snow fighting and meeting flood emergencies.

Volume and cost

In every state road upkeep is the largest of its public-works activities; it costs most, more men are employed, more machinery is used and more kinds of work are required. In Pennsylvania all these elements of big public-works business exist in noteworthy combination.

The upkeep of the Pennsylvania highways requires the maintenance of 38,084 mi. of road including 1,995 mi. of borough streets and 489 mi. of city streets. But there are also about 48,500 mi. of second-class township roads on which the state highway department may do work. Normally the state task is to take care of the 38,084 mi. only. In the twelve months ending May 31, 1938, the state expended in direct maintenance and repairs of these roads $28,991,180.

This total includes only direct items of upkeep; as the department balance sheet sets up expenditures there are separate charges for engineering and inspection, maintenance of detours, equipment purchases, building construction, flood repairs, etc. These charges amount to nearly $10,000,000; maintenance of course is not responsible for all of this expenditure but it required a considerable part of it, enough probably to bring the grand total a million or so dollars over $30,000,000. Now, even in this era of stupendous money expenditures, a business that costs over $30,000,000 a year to operate is big business.

What does this $30,000,000 do?

In general it keeps 38,000 mi. of Pennsylvania public roads fit for transport business—which is a perfectly uninformative answer. Again a drab citation is necessary. The items of work included, and these are not all, are: patching and repairing pavement; sealing joints and cracks; repairing and painting bridges; replacing and repairing cross drains; resurfacing and retreating bituminous pavement; resurfacing worn-out pavement; maintaining detours; erecting and repairing guard fence; shaping and dragging earth roads; dust laying treatment; mowing roadsides; cleaning ditches; erecting and maintaining traffic signs; painting traffic stripes; placing snow fence; cindering icy roads; removing snow and fighting erosion. And none of these include emergency work occasioned by floods, earth slides or other "acts of God".

Fig. 3. (Left) A section of the stockroom and (above) a corner of the machine shop in a modern maintenance division headquarters (Ohio).

The point of this enumeration is that in road maintenance it is the accumulation in scores and hundreds of small individual operations that is impressive; few of the operations are individually remarkable. Perhaps a battle against a blizzard snowfall is an exception and incidentally in the period covered by the cost figures given above Pennsylvania spent $3,500,000 for snow removal. Incidentally also, maintenance departments may properly give thanks to snowstorms as about the only occurrences that bring them public notice. Battle against snow is spectacular and a spectacle attracts when thousands of regular housekeeping operations receive no notice.

Men and organization

How are these numerous duties accomplished? Men and equipment are necessary—an army of both. In Pennsylvania the regular working force is about 13,000 men and at times it is increased to 15,000 or more men. In a blizzard it has been recruited to 38,000. Some 8,000 items of equipment, not including small tools, are the armament for this army of men; it cost over $10,000,000 and the replacements each year cost about $750,000. The chief material for repair work is asphalt, of which about 75,000,000 gal. are used every year. But overwhelming as the count may be, men, materials and machines alone do not win the battle against road wear and tear

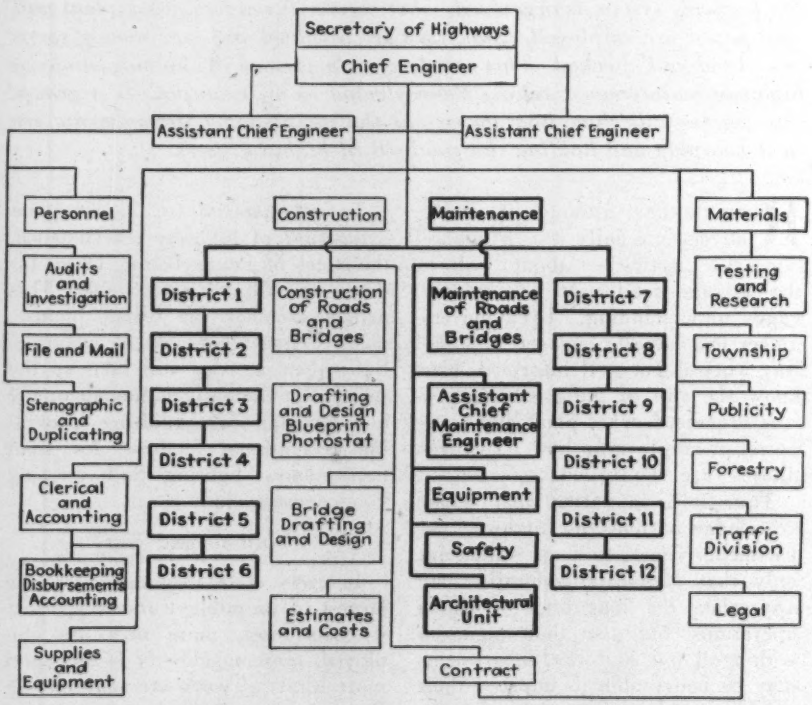


Fig. 2 Maintenance activities call for a large share of the administrative forces of a state highway department organization, as shown by this chart for the Pennsylvania department.

on 38,000 mi. of highway; organization and direction are equally essential.

Here one must turn to illustration for clear presentation. Fig. 2 is a much simplified organization chart of the Pennsylvania department of highways, in which the parts specifically concerned with maintenance are emphasized. For direct administration the state is divided into 12 districts each with a district engineer who has direction of both construction and maintenance of all state roads in the several counties forming the district. For maintenance a superintendent is assigned to each county except in one instance where a superintendent has charge of two counties, making 66 superintendents; with 220 assistants these men direct the actual field operations. Each has his force of workmen who are divided into small squads or assembled into companies as the operation requires.

Crew division is also based on the nature of the operation. To cite what may be an extreme example, it is obvious that skilled painters are required for bridge painting, not men picked up from a gang of graders. But specialization goes much farther, so that while there are maintenance operations that call for general-ability crews there are sub-operations that call for picked men, such as skilled cracksealers or asphalt-patchers. Then too, there are special equipment operations that call for picked crews; raising settled pavement by mudjacking is an example. And there are of course the mechanics and operators on trucks, rollers, graders and the dozen or so other types of maintenance machines. A district maintenance force is not a mob of recruits; it is a drilled brigade of variously trained men that can be mobilized for general attack on a blizzard snowfall or divided into squads or platoons to do several patching jobs or to carry on a larger operation of resurfacing.

Buildings and equipment

The district forces work out of headquarters buildings strategically located with respect to the bulk of the work. Formerly a rather temporary type of structure did service but in recent years definite permanence and more strict centralization have been sought in some 30 new "central garages." Actually, garage is hardly the right name for these really pretentious structures; besides housing equipment the new buildings provide administration offices and repair shops and are fireproof with modern heating, lighting and ventilating service. Description of garage buildings may perhaps be held incidental, but they effectually indicate the permanence of maintenance as a road transport activity and the investment of big business caliber required.

PENNSYLVANIA MAINTENANCE EQUIPMENT

Number of Units	Kind of Equipment	Original Cost
559	Automobiles	$332,346
30	Tractors	563,407
1,119	Trucks	2,708,922
32	Oil Distributors	138,647
11	Gas and Steam Cranes	67,376
6	Crushers	14,401
14	Crushing Plants	65,411
88	Air Compressors	120,654
1	Derrick	628
5	Steam Engines and Boiler	3,843
8	Traction Engines	19,744
2	Hoisting Engines	400
1	Finishing Machine	2,432
93	Concrete Mixers	88,616
118	Unloading Outfits	183,781
103	Steam and Gas Pumps	41,350
22	Steam and Gas Shovels	169,797
184	Rollers	512,506
10	Dump Carts	712
829	Heating Kettles	100,660
160	Line-O-Graphs	23,413
628	Graders	385,459
524	Motor Graders	1,324,286
1,530	Snow Plows	438,048
2	Scales	1,461
1	Scarifier	492
28	Wheel Scrapers	1,585
314	Storage Sheds	2,522,552
116	Sprinklers	44,111
408	Chip Spreaders	81,509
179	Stone Spreaders	41,301
116	Street Sweepers	45,282
29	Sweeper Scraper	2,607
1	Storage Tank	15
63	Trailers	67,776
69	Dump Wagons	9,555
4	Water Wagons	1,840
1	Sprayer	756
85	Mowing Machines, Drawn	13,135
59	Mowing Machines, Motor	6,643
19	Scrapers, Fresno	319
178	Air and Gas Drills	36,508
4	Road Maintainers	3,849
1	Drill Core	746
2	Concrete Surfacers	755
19	Tampers, Pneumatic	1,723
1	Gravel Plant	4,911
1	Drill Sharpener	1,000
2	Jacks, Mud	6,000
9	Equipment at Nursery	10,972
1	Jenny Clearing Device	1,036
2	Electric Welding Machines	2,818
7	Electric Arc Welding Machines	5,340
1	Multi-Pin Mixer	1,350
20	Crack Fillers	1,977
1	Retread Paver	1,000
1	Sand Blast Machine	384
1	Road Adjuster	359
12	Detachable Bit Grinders	3,090
34	Pavement Breakers	6,569
6	Bituminous Pavers	22,500
7,954		$10,280,712

Distribution of maintenance machinery to the districts is not a fixed thing; it swings back and forth with the flux in kind and amount of the work in the different districts. The best testimony of variety and volume of equipment is furnished by state totals as given in the accompanying table. To enable accurate occounting with a free flow of equipment, it is furnished to maintenance districts on a rental basis; each district thus pays for the service and the total rents balance the general equipment costs. Naturally much of the equipment in any district remains there steadily but any of it can be transferred when congestion of work in any place calls for a concentration of machines.

This capacity to mobilize extends to the captains and privates of the army of workmen. Generally it is called into service only to meet an emergency—a blizzard, snowfall, or a flood. In a state as large as Pennsylvania all are likely to be regional. When they are, men and machines move in from neighboring districts, as many as may be needed to meet the situation. It is even possible to make the mobilization statewide, and this virtually happened when the state was stricken by the great floods of 1937. This ability to mobilize is the crown of perfect maintenance organization.

But the most perfect organization machine fails if it lacks the quality of human relationship. In any modern maintenance organization public relations are recognized as having a large part in dictating organization policy and in the selection of the organization personnel. The district maintenance engineer or superintendent is about the only highway official that is known personally by the citizens of his county or district. To them he is the highway department. To the men who work on the road he is the employer, the paymaster, the exemplar of public relations. By his selection, the highway department stands or falls in securing goodwill of the public.

Country-wide service

What is being done in Pennsylvania serves to show that road upkeep meets every index of big business. It provides countrywide service, makes large expenditures, buys extensive plant and equipment, and has a trained organization with many workers. The people it serves are the nearly thirty million motor-vehicle users of America. How this big business functions will be set forth in detail in subsequent articles.

Soft Water for Southern California

A 100-m.g.d. lime-zeolite treatment plant will reduce hardness of Colorado aqueduct water supplied to Metropolitan District cities

LIME-ZEOLITE SOFTENING will be employed in the treatment of Colorado River water supplied by the Metropolitan Water District of Southern California. Approval of this was voted on Mar. 17 (*ENR* Mar. 23, 1939, p. 407) and plans were then announced for the construction of a 100-m.g.d. plant located on the district's main upper feeder near San Dimas. Provision is made for the ultimate expansion of the plant to a capacity of 400 m.g.d. Water will be reduced in hardness from 300 to 125 p.p.m.

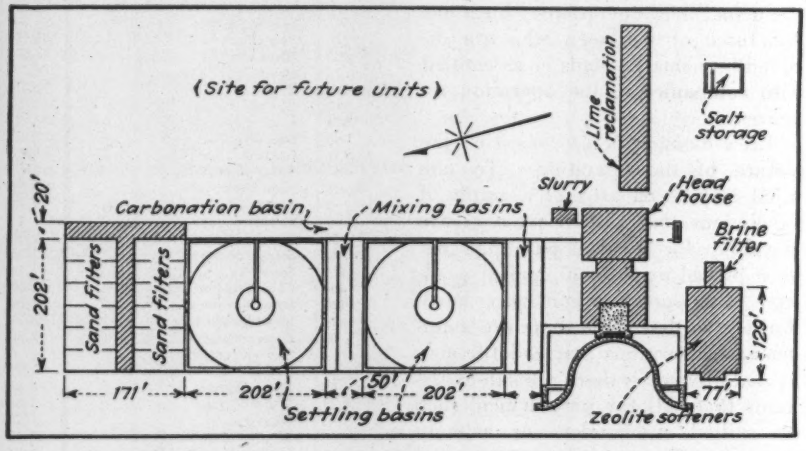
In his report to the directors of the district, F. E. Weymouth, general manager and chief engineer, states that the hardness of Colorado River water is due primarily to three compounds which are held in solution. These are calcium bicarbonate and the sulphates of calcium and magnesium. Two methods are particularly applicable for softening Colorado River water, namely: the excess lime-soda ash process and the lime-zeolite process. Due to the high sulphate hardness of the water, the lime-zeolite process has been found to be the most economical to use.

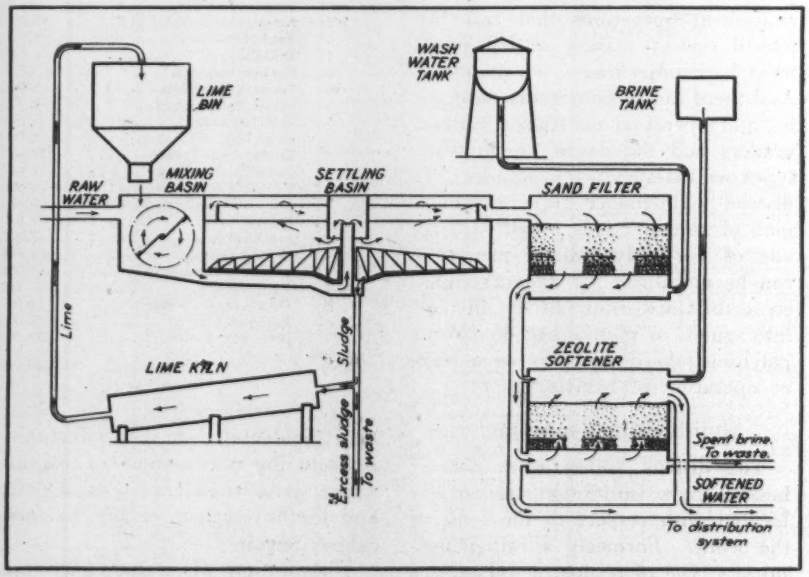
Coincident with the starting of plans for the treatment works, an investigation was begun of costs and sources of chemicals and adequacy of supplies. Lime, which would be required in either process, can be secured at a reasonable cost by reburning the calcium carbonate sludge removed from the water during the softening process. Both soda ash and salt are available in relatively large quantities in southern California. However, salt is more readily available. Accordingly, the plant is to be laid out primarily for lime-zeolite softening but it can be converted for excess lime-soda ash treatment should future conditions make this desirable.

The location of the plant is such that it will supply treated water to all of the member cities served by the present upper feeder; it could also serve a proposed future branch into middle Los Angeles and a proposed initial cross feeder from San Dimas to Fullerton, Anaheim, and Santa Ana. Complete details of the Colorado River Aqueduct distribution service were published in *ENR* Nov. 24, 1938.

Ultimate plans for the distribution system contemplate a line leading from the Cajalco Reservoir through Orange County and directly into the harbor area of Los Angeles County. If and when such a line is constructed, it will be necessary to provide a second treatment plant. This plant would be located east of the Santa Ana River and would supply softened water for municipal uses along the lower main feeder.

The operating cost per acre-foot of softening Colorado River water from 300 to 125 p.p.m., with the





General layout and flow chart of the 100-m.g.d. lime-zeolite softening plant. All the water will be treated with lime and filtered, but only a part of it will be passed through the zeolite softener. The latter portion will be blended with by-passed lime-softened water to regulate the degree of hardness of the final product.

plant running at design capacity, is estimated at $0.85 for operation and maintenance, $2.70 for chemicals, and $1.65 for interest and amortization, or a total of $5.20 per acre-foot of water softened. This is equivalent to $16 per million gallons.

The location of the San Dimas plant and the proposed location of the future plant on the lower feeder have been chosen with a view to getting the best possible service to present member cities and to prospective future annexations, according to Mr. Weymouth.

The plans for the softening plant were prepared by Hoover & Montgomery, consulting engineers, Columbus, Ohio. Contract for flocculators and sludge removal equipment has been let to the Dorr Co., Inc., New York City.

Model Rig For Rod Sounding

Contents in Brief—An unusually complete outfit for taking soundings in surveys for bridge foundations, developed by the bureau of bridges of the Ohio department of highways, is described and the operating methods are outlined.

AN EXCEPTIONALLY complete outfit for making rod soundings has been developed by the bureau of bridges of the Ohio state highway department, as illustrated. The first of these machines was built in 1932; the one illustrated is the fourth, and a complete transportation unit is included. This is the machine most generally used, but another, the second to be built, is a more elaborate one, including, besides the drop-hammer mechanism for rod sounding, a 3-in. churn drill, attachments for a small core drill and a power take-off for operating a rod-pulling jack. These parts are mounted on a four-wheel chassis for self-propulsion around the job; for longer hauls the whole rig is loaded onto a two-wheel truck trailer.

The machine illustrated is solely for making rod soundings. It is essentially a small pile driver, with 13-ft. leads, a 122-lb. drop hammer, a 4-hp. gas engine and power transmissions, mounted on I-beam skids as shown by the view showing the machine set up for operation. The two wheels shown at the sides are eccentrically journaled at the center of gravity of the machine so that by a lever they can be swung to lower the skids to the ground for rod driving or to lift them off the ground when moving to a new sounding. The power unit and transmission are best indicated by the diagram plan and elevation Fig. 3. About the only feature that requires further explanation is the drum control.

Note in Fig. 3 that the flange wheel against which the friction drive operates, and the cable drum, are mounted in bearings placed eccentrically on a shaft mounted on each skid, in such a manner that the operating lever may move the drum and flange wheel either forward or backward. By moving the lever backward (toward the motor) the drum is placed in operation and the hammer is raised. When the operating lever is moved forward (toward the leads) to a vertical position, the flange wheel and drum are released from the friction drive and the hammer is free to fall unless the operator shoves the lever further forward, placing the flange wheel tightly against the fixed brake shoe.

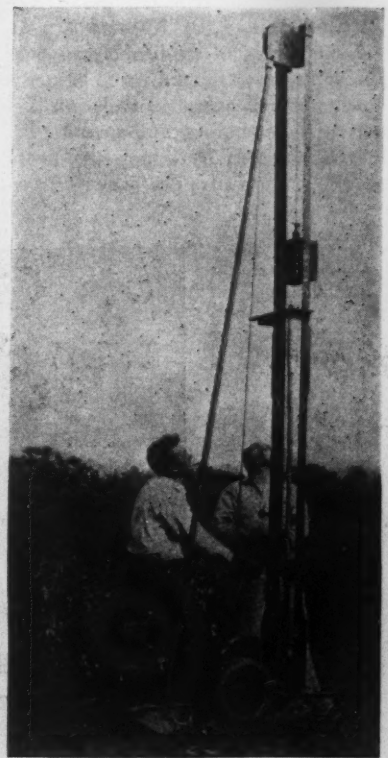


Fig. 1. Rod-sounding rig of the Ohio State Highway Department set up for operation.

Fig. 2. Follow-block and drive-head of alloy steel transmit hammer blow to sounding rod.

In operation the hammer strikes a follow-block which rests on a drive-head attached to the sounding rod Fig. 2. The follow-block has a socket to fit over the drive-head; the bottom of this socket is concave to fit the convex top of the drive-head and give the effect of a ball and socket bearing. Both follow-block and drive-head are of hardened chrome-vanadium steel. To connect the drive-head to the rod top its bottom is cored for a 4x$\frac{3}{4}$-in. stud; the rod is extra heavy 1-in. pipe and the stud is screwed into its inside-threaded top. Similar stud connections couple the 4-ft. sections of pipe by which the rod is lengthened as it is driven. The studs are case-hardened nickel steel to withstand the heavy stress when the rod is pulled out of the ground. For driving, the bottom section of pipe rod has a 5-in. tool steel shoe 1 in. in diameter and with a 45-deg. point; this shoe is attached to the rod by a stud connection simi-

lar to the sounding rod couplings.

The sounding procedure is ordinary except that accurate observations and measurements are secured. When a test hole is uncompleted at the end of the day, the operating handle is detached and the covers, shown by Fig. 4, are slipped over the rig and locked in place. The two separate covers are much easier to handle than one odd-shaped cover. To keep the weight down and still make a fairly rigid and protective cover, 20-gage sheet metal is used.

When the job is finished the leads and diagonal bracing are disconnected from the base of the rig and pulled up on the roof of the truck over a special roller support. When pulled in place the leads are clamped down both in front and back of the truck. With the leads removed and stored away the rig is started up the demountable runways aided by a hand-operated winch. The winch placed under the rear of the truck holds about 200 ft. of $\frac{3}{8}$-in. round cable and is operated by a detachable handle on the right side of the truck. Note how the longer rods, sampling tools, etc., are stored away in truck; this manner of loading of the longer pieces of equipment prevents possible damage to the interior of the truck and increases the ease in handling them in and out of the truck.

For the information and illustrations contained in this article the editors are indebted to J. R. Burkey, chief engineer, bureau of bridges, Ohio Department of Highways, Columbus, Ohio.

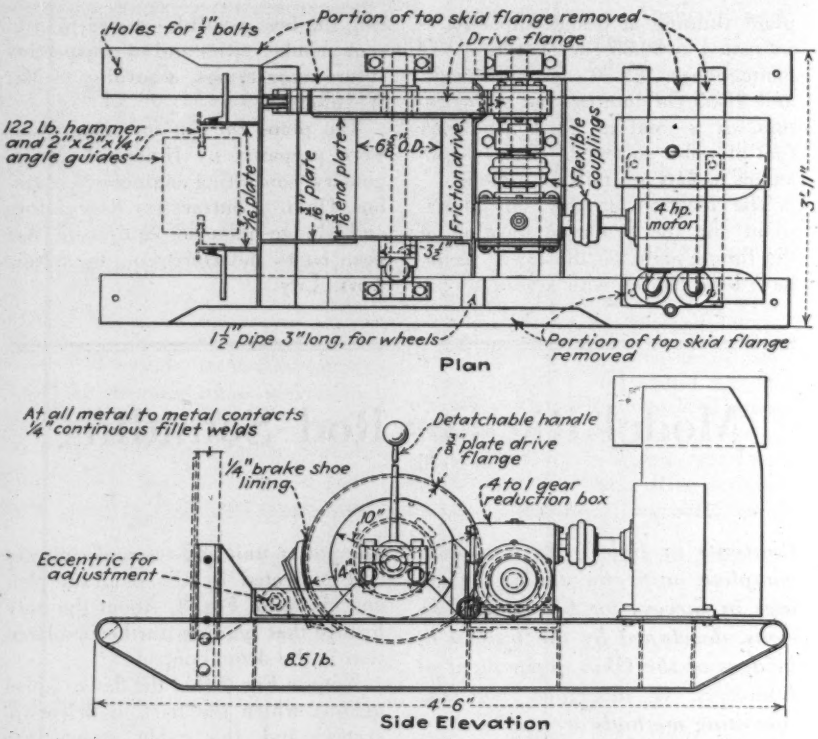


Fig. 3. Power and transmission units compactly mounted to permit transportation in body of service truck.

By a series of studies begun over six years ago, the bureau engineers have worked out a correlation between rod-sounding and actual pile-driving records by which the probable behavior of piles when driven can be predicted before construction is started. The results of the early tests with their interpretation, correlation with the accepted theory of piling and comparison with actual construction are given in Engineering Experiment Station Bulletin 90, Ohio State University, Columbus, O.

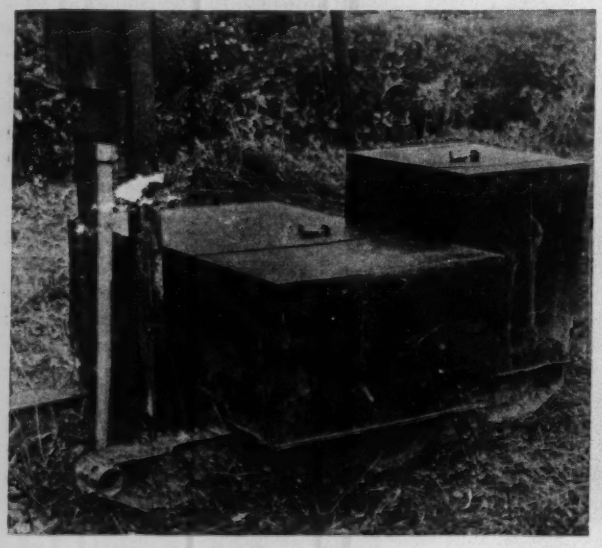


Fig. 4. Steel covers protect power and transmission units during intervals when the machine is not in actual operation.

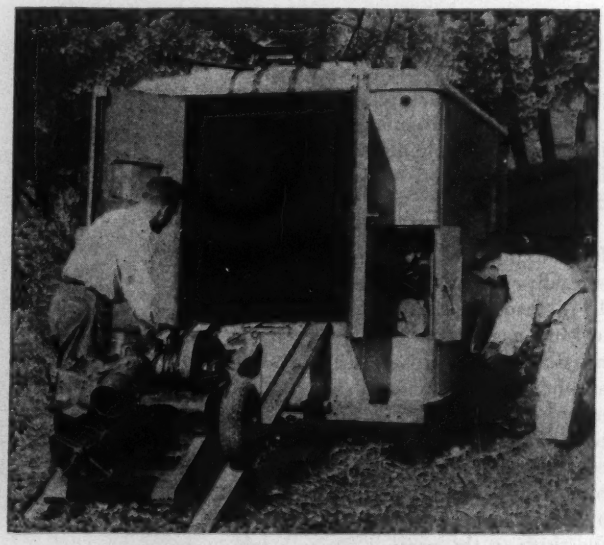


Fig. 5. Compact storage for transportation is provided by a service truck having compartments for the smaller parts.

Civil Engineers Meet in TVA Area

Spring meeting of Am. Soc. C.E. in Chattanooga, Tenn., treated members to a program built around the engineering activities of the Tennessee Valley Authority

FOR FOUR DAYS last week, April 19-22, over 1,200 members and guests of the American Society of Civil Engineers were given an exceptional opportunity to learn about the design and construction activities of the Tennessee Valley Authority and to see some of the dam building work in progress. The program of the 1939 spring meeting at Chattanooga, Tenn., contained a dozen papers on TVA work and in addition included a symposium on dams which, while general, was in harmony with the type of TVA work described. The initial meeting of the new hydraulics division involved a program of 22 papers and prepared discussions, and was an acknowledged success. The convention was in charge of Lee G. Warren, president of the Tennessee Valley section.

One of the largest meetings ever held by the society outside of New York City, the Chattanooga meeting developed genuine and sustained interest in all of the proceedings and in only one respect was there any dissatisfaction voiced. This was in connection with the meeting committee's decision to deny any representation on the program to the former engineering heads of the TVA. Characterized by many as a partisan action not worthy of the professional standards of the society, the issue finally came to a head through an attempt by A. J. Ackerman to present for consideration a resolution asking that the society "acknowledge its indebtedness to Arthur E. Morgan and Carl A. Bock for the important contributions made by them in the field of river control engineering and in their administration of the engineering and construction program of the Tennessee Valley Authority in accordance with the highest engineering standards and ideals." To avoid a discussion which, as he said later, he felt would be acrimonious, President Sawyer, who was aware that the resolution would be offered, adjourned the meeting before the resolution could be presented. No vote, therefore, was allowed, but at the next session it was announced that the resolution would be referred to the board of direction.

Prior to the convention the board of direction held a two-day session. Kansas City, Denver and Cincinnati were selected for the 1940 meetings. A committee of the board headed by J. E. Root was requested to study the salary and classification schedule received in January in the light of the suggestions received from 20 sections, various organizations and individuals and to report at the San Francisco meeting.

Some 34 sections have appointed 160 men to professional objectives committees, E. R. Needles reported for the national committee, as evidence of the widespread interest in the professional and welfare status of the members. A meeting of the committee to be held in St. Louis July 1.

Concurrent conferences were held by the student chapters of the southeast to which 27 chapters sent 200 representatives; also the southeast local section conference discussed professional problems.

Highlights of the opening session were papers by Theodore B. Parker, chief engineer of the TVA, on the work of his organization and by Brig. Gen. Harley B. Ferguson, division engineer, Corps of Engineers, Vicksburg, on Mississippi River flood control. The latter paper was presented by George R. Clemens, senior engineer, Mississippi River Commission, Vicksburg. With only a few exceptions, the papers covered material previously reported in these pages. Mr. Parker called attention to the satisfactory progress being made on Hiwassee Dam, which will be one of the highest overflow dams in the world. He also said that preliminary construction work is underway at Gilbertville Dam, near Paducah, Ky., and that work will start soon on Watts Bar Dam about 60 miles above Chattanooga.

In discussion which followed, A. C. Polk, consulting engineer, Birmingham, Ala., characterized the flood control provisions of TVA as inadequate and only incidental to the main purpose of the program which is to generate power. He said Chattanooga needs upstream protection storage twice that to be supplied by Norris and Hiwassee Dam and that the 4,600,000-acre-ft. storage at Gilbertsville provides no protection to the Tennessee Valley.

Mississippi River cutoffs

Gen. Ferguson's paper outlined the success which has attended operation of the cutoffs constructed along the Lower Mississippi River. For example, comparing the rating curves at Vicksburg at a flow of 1,300,000 sec.-ft., the March, 1939, rise is lower by 7 to 9 ft. than either 1929 or 1932 at this flow. At Arkansas City in 1928 and 1932, before the cutoffs and channel improvement work, a stage of 53.5 ft. at a flow of 1,430,000 sec.-ft. was recorded. This year at the same flow the stage was 15 ft. lower.

Treating dam foundations

Papers on the geology and foundation treatment at Chickamauga and Guntersville damsites comprised the program of the soil mechanics and foundation divisions. Chickamauga geology was described by Portland P. Fox, and Chickamauga foundation treatment by James B. Hays. The rock at the site consists largely of thin-bedded limestones and thin interstratified beds of shale and bentonite intricately folded and faulted and filled with solution seams and caves. Under the concrete river dam most of the cavernous top layer of rock could be removed, but under

the flanking earth dikes complete removal was not economical and much grouting was necessary. Consolidation grouting was used over the entire riverbed portion of the site. Details of the work under the dikes is given on p. 59 of this issue. (See also *ENR* Oct. 21, 1937, p. 665.)

C. E. Blee, TVA project engineer at Hiwassee Dam, said that the thoroughness of grouting at Chickamauga probably never had been equalled. He also emphasized the importance both to exploration and to cavern filling of the 36-in. calyx drill holes.

Guntersville geology was covered by Robert M. Ross and foundation treatment by Verne Gongwer. Conditions were not as difficult as at Chickamauga although they were similar in nature, that is, a layer of eroded limestone existed on top of a 3-ft. layer of shale that protected the limestone beneath it. Principal difficulty in the main dam section arose from leaky cofferdams which blew and flooded several times. The rock was eroded into small rhombic blocks and pressure through the seams around the blocks was too great to be pumped against. The final and successful solution was to grout holes on 5-ft. centers along the cofferdam cells forming a cutoff curtain. In excavating for the main dam all of the eroded rock down to the shale was removed; consolidation grouting of the entire area and cutoff grouting as at Chickamauga followed. Under the earth dikes, however, all bad rock could not be removed and a sheeted trench was carried down on the line of the sheetpile cutoff to remove residual boulders and to fill cavities that extended under the dam. Holes on 2-ft. centers were put down along the toes of the sheetpiling and grouted with 40 to 50 lb. pressure. Finally a concrete sealing wall was built up around the bottom of the sheetpile cutoffs. One cavern under the north abutment was 2,500 ft. long and 20x30 ft. in section; this was effectively closed by a concrete bulkhead.

Masonry dam symposium

The symposium on masonry dams, sponsored by six of the technical divisions of the society, included seven papers, and six more will be presented at the July meeting in San Francisco. The objective of this ambitious program, to which a large group of eminent engineers have contributed, is to bring together in one place information on the modern theories and practices in a field which has witnessed important changes in recent years. Because of the voluminous nature of the papers and because they constitute merely a restatement and assembly of established practices any abstract would be both inadequate and pointless.

Several discussions in this symposium brought out items of interest which may be reported briefly. For example at Conchas Dam, a concrete gravity structure now nearing completion in New Mexico, the natural recharging of the artesion sandstone foundation, which was pumped down during the early construction period, has caused the rock to recover the settlement caused by the pumping and thus to lift the entire dam as much as 1 in. Both Capt. Hans Kramer, who is in charge of the work, and Lt. Alden K. Sibley, who reported on the phenomenon, expressed the belief that it was unprecedented in dam building experience.

Duff A. Abrams, consulting engineer, New York, expressed a number of criticisms regarding Bureau of Reclamation dam building practices. In his opinion air-water jet cleaning of construction joints dangerously weakens bond; uplift at horizontal joints is several times greater than assumed; proportioning of Grand Coulee concrete is very uneconomical and 30 per cent less cement could be used at a saving of $5,000,000;

Hiwassee Dam, a combined power and storage project of the Tennessee Valley Authority on the Hiwassee River, 22 miles below Murphy, N. C., to which town the reservoir will extend. The dam will be 307 ft. high. 395,000 cu.yd. of concrete had been placed when this picture was taken at the end of March.

washing and classifying the sand at Grand Coulee is wholly unnecessary and detrimental.

Several speakers urged the use of dynamic methods of earthquake analysis, which take possible resonance of foundation and dam vibrations into account. Ross M. Riegel, TVA, cautioned against too much blasting of dam foundations. A dam foundation is not a quarry, he said. Barton M. Jones, TVA, suggested the use of lower grouting pressures and more holes to avoid disturbing foundation rock. James P. Growden, Aluminum Company of America, said washing of rock seams is questionable practice; if grout does not remove the natural material let it stay.

Surveying and mapping

In the surveying and mapping division meeting, in discussing boundary surveys, Prof. A. H. Holt, Worcester Polytechnic Institute, pointed out that state systems of plane coordinates had been legalized in New Jersey, Pennsylvania, New York and North Carolina and that bureaus for their administration had been authorized. Prof. Philip Kissam, Princeton University, suggested that the system of land descriptions used by the Massachusetts Land Court, which utilize ties to nearby monuments instead of metes and bounds, be generally adopted. While describing city surveys, R. H. Randall, consulting engineer, Washington, D. C., mentioned the widespread use of Manual No. 10, "Technical Procedure for City Surveys," published by the Am. Soc. C.E.

The high point of the meeting was the announcement by J. H. Pratt, consulting engineer to the director of the U. S. Geological Survey, that, in reply to Senate Resolution 87, a report had been submitted jointly by the Secretaries of Commerce, Interior and War requesting an immediate appropriation of $5,000,000 to begin a program of mapping the United States.

T. P. Pendleton, a section chief, U. S. Geological Survey, Chattanooga, in describing the use of the multiplex projector, pointed to the great increase in accuracy that has been attained. The multiplex procedure which affords great economies in plotting from aerial photograph, has been improved partly as a result of the new 45-deg. wide angle lens but chiefly as a result of the 3-in. slate tables which are ground to within 0.002 in. of a plane surface. Other improvements include new accuracy in matching projector and camera lenses, storage of film in refrigerated rooms and the use of air-conditioned plotting rooms. He said the master maps are made at a scale of 1:10,000 and reduced to 1:24,000 with a resulting accuracy of 0.007 in. in horizontal position on the final maps. Test profiles with transit and level are run, he said, and it is found that 4.5 ft. is the average error found in contour elevation. In discussion, George Whitmore urged that all survey control points be shown on these maps so that engineers will be able to tie future surveys to them easily and accurately.

In constructing embankments across TVA reservoirs, the most economical have proved to be those made with a compacted earth core having slopes of 1 on 1½ and protected by a 4-ft. thickness of rock revetment, according to F. E. Junior, TVA highway engineer. Careful selection of fill materials and placement in layers no thicker than 6 in. are essential. A second paper on the highway program outlined Alabama's low-cost road practices which have been brought to a high state of success by major attention to base course construction. Leon Gottlieb, bituminous engineer of the highway department, listed an 8-in. thickness, a 3-in. crown in a 20-ft. width and carefully supervised subgrade compaction as essentials. Sand-clay or gravel are the base course materials. The wearing course consists of cutback asphalt or tar in two applications which is then sanded and covered with 35 lb. per sq.yd. of cold plant mix material.

Hydraulics

The newest technical division, hydraulics, has started with the third largest membership, 1,800. It put on a full day's program before a crowded hall. In one of the outstanding papers, Gerard H. Matthes, principal engineer, Mississippi Power Commission, made a plea for field study of hydraulic phenomena or "observational hydraulics" to differentiate it from experimental hydraulics on models. Field technique is almost non-existent and needs developing, he said. Since it is difficult to get funds for testing facilities after a structure has been built, Mr. Matthes stated that the time to provide for hydraulic observations is at design and cost-estimating period.

In discussing moving pictures of the Norris spillway and stilling basin, J. E. Warnock, hydraulic research engineer, U. S. Bureau of Reclamation, indicated the difficulties of making measurements on prototype. The pictures disclosed that a large amount of air is entrained in high velocity water which changes the characteristics of the flow. Development of equipment sturdy enough to withstand the high velocities is difficult. A salt-velocity method has succeeded in measuring velocities up to 110 ft. per sec. The high-speed motion picture camera is a valuable tool, Mr. Warnock has found.

F. C. Scobey, chairman of the hydraulics division, presented colored slides of hydraulic jump in wanted and unwanted places. He indicated the various uses to which the jump has been put and the difficulties where shooting flows have been injected into streaming flow in flumes, conduits and channels. Sinuous canals designed for velocities just under the critical may give unexpected jumps with disastrous overflows.

Construction plant

Three papers in the construction division covered time studies and plant layouts for large dams and for buildings. F. C. Wardwell, senior civil engineer, TVA, indicated enormous savings effected by time study crews on numerous continuous and repetitive operations. For example, by utilizing detachable drill bits at Norris Dam in competition with forged bits on 226,000 ft. of hole, the former proved decidedly more effective.

R. T. Colburn, construction plant engineer, TVA, outlined the work of the TVA construction-plant division in studying, estimating and designing the main plant for each of the ten dams and in administering $5,000,000 worth of equipment. Mr. Colburn concludes that TVA experience is typical of the trend in heavy dam construction toward closer cooperation and understanding among the engineer, the designer and builder, more thorough administration and control of construction equipment, more careful planning of plant and operations and more studied attention to processes and methods.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

SLUDGE DENSITY — Physical methods of increasing the density of raw and activated sludge appear to be effective. Since sludge must be handled on a volumetric basis in any type of treatment, densification is important. Methods to increase the density of activated sludge include the addition of coagulants, inert materials, temperature changes, electrolytic treatment, etc. Centrifuging has been employed to produce a dry cake. After considerable experimentation Manchester, Eng. (Rivers Dept. *Report* 1938) has found that centrifuge treatment gives the most promising results. The activated sludge was densified up to 5.3 per cent. Sludge densified to this extent was found to be stiff and probably difficult to pump; a solid content of 3.5 per cent has been suggested as the upper limit.

FILTER CLOGGING—Clogging of trickling filters with fatty substances is not necessarily caused by large quantities of fat in the sewage. By treating an experimental filter with sugar alone it is possible to clog the whole of the filter in a very short time. Jenkins (*Proc.* Inst. Sew. Purif. England Part II, p. 31, 1937) states that this has been done innumerable times and under all sorts of conditions. Fats need not actually be present in sewage before fat is found on the upper surface of the filter. Microorganisms can often synthesize fat from substances like sugar. Therefore, the greasy appearance and clogging of filters may be caused by industrial or trade wastes containing carbohydrates and sufficient available nitrogen to sustain bacterial life in the filters.

PIPE CORROSION—Stale sewage containing hydrogen sulfide and other corrosive substances is a constant source of trouble. In an endeavor to prevent internal corrosion of large riser pipes Borrie (*Journal* Inst. Eng., Australia, 35, 1938) coats them with a mixture of pitch, coke oven tar and finely ground limestone in proportions of 53:17:30. This material has a melting point between 60-65 deg. C. and is applied with a special machine. After the pipe is cleaned with wire brushes operated by compressed air, a priming coat of tar pitch, coal tar and benzol (33:18:49) is sprayed on and enamel applied.

The machine consists of an asbestos-coated tank with passages to permit circulation of hot air from the combustion chamber beneath. Heat is applied by kerosene burners. The tank contains a positive displacement pump which forces the liquid enamel in a pressure vessel and thence through posts into the adjustable, revolving jet arms, from which it is discharged through slotted jets about 2 ft. in front of the machine. After placing the machine in position the compressed air motor moves the machine forward at about 6 ft. per minute. The machine operated very successfully in 4 and 6-ft. dia. mains. Coating placed 2½ years ago is still in excellent condition, but in some places the enamel failed to adhere properly, resulting in blisters. But corrosion has been arrested.

REFUSE FERMENTATION—When refuse contains large amounts of vegetable refuse and fish wastes, fermentation for the production of fertilizer seems logical. A variety of fermentation processes have been used, some with good and others with indifferent success. Fermentable material can be destroyed readily, however, under proper conditions. Humery (*Technique Sanitaire* 33, 182, Sept. 1938) gives a description of the advances made in France, and particularly of a process capable of producing a humus, which can be directly utilized in agriculture without being offensive.

Garbage is placed into completely closed cells where it is aerated with compressed air. Aerobic thermophilic bacteria develop rapidly in the tanks raising the temperature to about 140 deg. F. (2-3 days) and to 170-180 deg. F. in 5 days. It remains at 150 to 165 deg. F. for 20 days when the material is discharged. The residue is an inoffensive humus-like mass, which is mechanically sifted to remove rags and paper, scrap metal, and other inert materials. The rags and paper are burned, the metal sold, the stones, gravel, glass, etc., used for fill; ashes are mixed with the humus which is supplied to the farmers. The humus is in good physical condition for soil building. Since soil scientists and agriculturists maintain that humus must be added to the soil together with chemical fertilizers, the product is in constant and growing demand.

FILTER AERATION—Years ago trickling filters at Atlanta, Ga., were equipped with ventilators designed to supply the lower sections of the filters with air and remove gaseous biological end-products. Their usefulness was not apparent, however, and they were abandoned. During the last few years the question of ventilation has been revived both in this country and abroad. Recently elaborate aeration and de-aeration systems were built in the Stuttgart plant. Sohler (*Gesundheits Ingenieur*, Dec. 24, 1938) describes the installation, consisting of a number of 4-in. pipes placed upright. With a settled sewage of 97.5 p.p.m. B.O.D. the final effluent contained 20.3 p.p.m. with normal load of about 300 gal. per cu.yd. of filter material. When the load was doubled clogging occurred with consequent deterioration of effluent and attendant odors. When a better distribution system was installed on a section of the filters the dosage rate was increased 6 times. After one year's operation the overall B.O.D. reduction (including settling) was 85.2 per cent for low-rate filters, and for high rates on the same filters with better distribution 82.7 per cent. When the final effluent was properly settled the overall B.O.D. reduction amounted to 92.4 per cent. During the first few weeks of higher dosage some pooling was observed, but the sludge was apparently washed out, because no further difficulties occurred. It appears that no special aeration or recirculation of effluent was necessary when the sewage was properly distributed on the filters and final settling was practiced.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Black Traffic Stripes Made of Asphalt Mastic

ROBERT ROOT
Des Moines, Iowa

A traffic stripe of asphalt mastic about 7/8 in. thick has shown good service in a trial installation at Des Moines, Iowa, and city traffic engineer Harry Stedman indicates that its use will be extended. The trial striping was placed on an eight-lane brick pavement in June, 1938, and neither the summer heat, winter cold nor the use of snowplows has cracked or warped the stripe. The mixture used was 50 lb. of 60–65 penetration asphalt, 30 lb. of stone dust and 370 lb. of sand. It was laid between forms of 6-in. boards laid flat; the brick surface between forms was first painted with hot asphalt and then the hot mix was ironed in place flush with the 7/8 in. thick boards. By this construction the edges were left somewhat sharp but they were soon rounded by traffic. Since installation the stripes have compacted and worn down to about 1/2 in. thick.

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Bar Bending Schedules For Girder Ends

W. G. GOODWIN
Truscon Steel Co., Boston, Mass.

At the end of deep girders reinforced with heavy bars, bent for shear and having hooked ends of large diameter, bending schedules require careful detailing.

The accompanying table showing points of tangency at hooks for some common slopes will cover most cases. For intermediate slopes and ordinary hook diameters interpolation will usually be close enough. Special cases may be solved by the formulas lettered on the accompanying diagram.

$\phi = 15°$	$\phi = 30°$	$\phi = 45°$	$\phi = 60°$
$x_1 = .63\ J$	$x_1 = .75\ J$	$x_1 = .85\ J$	$x_1 = .93\ J$
$y_1 = .017J$	$y_1 = .067J$	$y_1 = .15\ J$	$y_1 = .25\ J$
$x_2 = .37\ J$	$x_2 = .25\ J$	$x_2 = .15\ J$	$x_2 = .067J$
$y_2 = .98\ J$	$y_2 = .93\ J$	$y_2 = .85\ J$	$y_2 = .75\ J$

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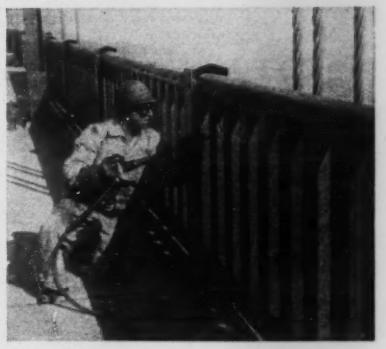
Railings As Wind Breaks

Anemometer readings measuring wind velocity on the Golden Gate Bridge, San Francisco, indicate a means of reducing the by no means negligible hazard to automobiles where a gale sweeps a bridge roadway. Last February automobiles crossed the bridge safely during a 75-m.p.h. wind (*ENR*, Feb. 24, 1938, p. 311). The recent anemometer readings showed a velocity of 42 m.p.h. over the top of the bridge rail at a time when the velocity was only 21 m.p.h. on the roadway midway between the railings, which are 80 ft. apart. In other words, in the lee of a steel railing 5 ft. 3 in. high, the wind velocity was reduced by one half. The railing panels are made up of 4-in. I-beam sections (10 lb. per ft.) spaced on 9½-in. centers—i.e., there is a 5½-in. open space beside each 4-in. vertical beam. Readings at the top of the towers show that wind velocities 746 ft. above water level sometimes are less than on the bridge roadway which is only 240 ft. above water level at midspan. The wind velocity observations were made by Russell G. Cone, engineer, Golden Gate Bridge and Highway District.



This 5-ft. railing on the Golden Gate bridge reduces wind velocity on the roadway by one half.

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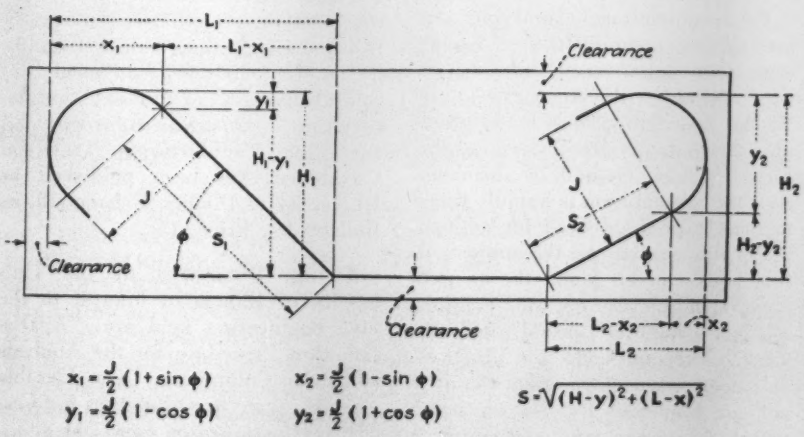
Radio Control of Pumps

Until recently Sioux Falls, S. D., controlled the operation of the well pumps at the north edge of the city by 40 overhead wires, the motors being started or stopped by switches at the power station and main pumping plant. The well field was a level tract a mile from the main station and was selected as the site for a modern airport. To remove the hazard of the overhead wires it was essential that the remote-control system be rerouted, rebuilt and a portion put in an underground conduit. Estimates of the cost to revamp the system ran to $28,000.

Investigation of all the remote-control systems available led to the installation of a wire radio remote control system made by the Line Material Co., East Stroudsburg, Pa. Only two wires are required to control the eleven well pumps with sufficient additional controls to handle outlying street lighting, off-peak hot-water heating units, display windows and other similar usages. The system has been in satisfactory service since Dec. 1, 1938, according to Joseph S. Nelson, commissioner of the Sioux Falls waterworks.



$x_1 = \frac{J}{2}(1+\sin\phi)$ $\quad x_2 = \frac{J}{2}(1-\sin\phi)$

$y_1 = \frac{J}{2}(1-\cos\phi)$ $\quad y_2 = \frac{J}{2}(1+\cos\phi)$

$S = \sqrt{(H-y)^2+(L-x)^2}$

Bar bending diagram for deep reinforced concrete girders.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Water Supply

WATER SUPPLY ENGINEERING—By Harold E. Babbitt and James J. Doland. Third Edition. Published by McGraw-Hill Book Co., New York and London. 690 pp. Price $6.

The difficulty of keeping a book up-to-date in such a diversified and changing field as public water supply without exceeding reasonable bounds has been well met by Babbitt and Doland in the revised edition of their *Water Supply Engineering*.

For the benefit of those who have not seen the earlier editions it may be noted that the book treats of waterworks finances, hydraulics, rainfall and runoff, and water consumption; ground and surface waters and their development by means of wells, dams and reservoirs, aqueducts and various types of pumps.

Specialists in the many divisions of the broad field covered by the book could readily point out scanty treatment and statements misleading by their brevity. For them, a score of special treatises are available; but even they will find this concise review of their fields highly useful, especially in view of the fact that by no means all of the special treatises are up-to-date.—*Reviewed by* M. N. BAKER, *Upper Montclair, N. J.*

Arch Dam Design

DESIGN OF DAMS—Second Edition. By Frank W. Hanna and Robert C. Kennedy. 478 pp. Published by McGraw-Hill Book Co., New York and London. Price $5.

Major emphasis in this book is placed on the design of arch dams, especially on an exposition of a theory of design developed by the authors. Other types of masonry dams are treated briefly as are rockfill and earthfill dams. There also are chapters on the basic theories underlying all dam design, on related hydraulic problems, and on dam accessories. Because of the large amount of space devoted to arch dam design in so small a book, the treatment of other types is necessarily so sketchy as to limit the usefulness of those sections. Further, the section on earth dams is quite out of date, there being no reference to the revolutionary developments since the first edition was printed. Tables of dams, flood flows, etc., have not been revised to take account of the remarkable floods of recent years.

Aqueduct History

HISTORY AND FIRST ANNUAL REPORT—Metropolitan Water District of Southern California. 355 pp. Published by the district, Los Angeles. Price, paper 50c., cloth $1.

This book gives a history of the project to bring Colorado River water to Southern California together with a comprehensive outline of the planning and construction of the 220-mi. aqueduct system. Attention is given to each phase of the undertaking such as surveys, location, financing, design, specifications and contracts, testing and purchasing. There are numerous pictures and reproductions of engineering drawings as well as much information, tabular and in text, on the use of water in the south coastal plain, construction costs, principal contracts, personnel and a copy of the Metropolitan Water District act.

Sewer Service Charges

SEWER RENTALS—A study by the American Public Works Association in cooperation with Municipal Finance Officers Association and American Municipal Association. 113 pp. Published by American Public Works Association, Chicago. Price $1.50.

In accumulating, classifying and interpreting administrative experience with sewer-service charges in over 100 cities, the American Public Works Association has made available the first complete analysis of this relatively new method of financing. And the presentation is happily timed to meet a pressing need for authoritative information on the subject. In this book can be found the answers to practically every question concerning rate structures, special rate problems, billing and collection practices, and disposition of revenue. But it is not an academic treatise on sewer rental philosophy, nor is it simply a questionnaire census of cities which employ this method of revenue-raising. It is a practical exposition of facts and theory revealed from a study of procedures in 104 cities varying in size from 600 to 300,000 population. Municipal officials who are considering the adoption of sewer service charges to meet operating expenses as well as to finance new construction, need this book to make an intelligent appraisal of the merits, weaknesses and methods of application of this system.

Traffic Engineering

1938 PROCEEDINGS OF INSTITUTE OF TRAFFIC ENGINEERS—106 pp. H. F. Hammond, secretary-treasurer, 60 John St., New York City. Price $1.

Mounting interest in traffic engineering and meagerness of literature on that subject make the proceedings of the Institute of Traffic Engineers more than ordinarily desirable for interested officials of smaller cities without traffic engineering departments. In the larger cities where specialists are employed the engineers of the traffic department will find much valuable data on modern practice in the 19 papers and discussions contained in this book.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

THE SYMPOSIUM ON IMPACT TESTING, held at the 41st annual meeting of the American Society for Testing Materials, has been published in pamphlet form by the society as a reprint from its *Proceedings*. Price, $1.25.

THE FOURTH PROGRESS REPORT of the joint investigation of fissures in railroad rails being conducted jointly by the Engineering Experiment Station, University of Illinois, the Association of American Railroads and the Rail Manufacturers Technical Committee, has been published as University of Illinois, Urbana, Ill. as Bulletin 93. Price, 15c.

OTHER BULLETINS of the University of Illinois of interest to the civil engineering field are: "A Distribution Procedure for the Analysis of Slabs Continuous Over Flexible Beams", price $1; "Solution for Cer-

(*Continued on page 74*)

Had they been built
to work upright,
A longer life they'd rate.

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TIGH
BOU

Old demon Dust is all
stretched out
Just havin' lots of fun.
These horizontal
contacts prone,
Can't shake the dirty bum.

They have to cook and
fry and roast.
That is their sordid fate.

Had they been built
to work upright,
A longer life they'd rate.

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ACCOMPLISHMENTS of the Works Progress Administration are summarized in a large pamphlet entitled "Inventory—An Appraisal of the Results of the Works Progress Administration". Much of the data is published in the form of full page pictorial plates.

AN ORIGIN AND DESTINATION survey of vehicular traffic was made recently in the Chicago Park District. WPA furnished the personnel but Otto K. Jelinek, traffic engineer of the park district, directed the work. That traffic concentration is directly in proportion to population and recreational, industrial, commercial and other activities is the principal conclusion. Another statement is that the central business district dominates the traffic trend and is the hub of traffic distribution. A plea is made for limited ways. This 41-p. monograph is the fifth of a series dealing with various traffic problems.

NEW PUBLICATIONS

A MANUAL OF THE SLIDE RULE—By J. E. Thompson. 220 pp. Published by D. Van Nostrand Co., Inc., New York. Price $1.75.

LOW DAMS—A Manual of Design for Small Water Storage Projects. 431 pp. Prepared and published by the National Resources Committee. Price $1.25, Superintendent of Documents, Washington.

REORGANIZATION OF THE NATIONAL GOVERNMENT — WHAT DOES IT INVOLVE?—By Lewis Meriam and Laurence F. Schmeckebier. 272 pp. Published by the Brookings Institution, Washington, D. C. Price $2.

HEATING, VENTILATING, AIR CONDITIONING GUIDE, 1939—1,160 pp. Published by the American Society of Heating and Ventilating Engineers, New York. Price, $5; thumb indexed edition, $5.50.

IDRAULICA—Basi Scientifiche e Applicazioni Techniche—Vol. I, Part I, Second Edition. By Giulio de Marchi. 200 pp. Published by Ulrico Hoepli, Milan, Italy.

PUBLIC UTILITY APPRAISALS—47 pp. Prepared and published by Jensen, Bowen & Farrell, Ann Arbor, Mich.

PROCEEDINGS OF THE MONTANA NATIONAL BITUMINOUS CONFERENCE—620 pp. Published by the Montana State Highway Commission, Helena, Mont.

TRENCH, SURFACE, BOMB-PROOF AND OTHER AIR-RAID SHELTERS—By Ove N. Arup. 63 pp. Published by Concrete Publications, Ltd., 14 Dartmouth St., Westminster, S. W. 1, London. Price, 6s. 6d.

THE NILE BASIN—By H. E. Hurst and P. Phillips. 728 pp. Published by the Ministry of Public Works, Government Press, Cairo, Egypt.

REINFORCED CONCRETE BRIDGES—By F. W. Taylor, S. E. Thompson, Edward Smulski. 456 pp. Published by John Wiley & Sons, New York; Chapman & Hall, London. Price, $6.50.

CONNECTICUT GROUND WATER SURVEY—Record of Wells, Springs and Ground-Water Levels—Bulletins GW-1 to GW-6, inclusive. About 200 pp. each. Prepared and published by the Works Progress Administration for Connecticut and the Connecticut State Water Commission, under the direction of the Geological Survey, Hartford, Conn.

REPORTS AND PAMPHLETS

THE ENGINEER AND THE PUBLIC, Association of Professional Engineers of Manitoba, Winnepeg, Man.

CALCIUM CHLORIDE AND PORTLAND CEMENT, Solvay Sales Corp., New York.

HIGHWAY COSTS, C. B. Breed, Clifford Older and W. S. Downs. Submitted to Association of American Railroads.

THE STREAM CONTROL COMMISSION, Fourth Biennial Report, Lansing, Mich.

CRUSHED STONE INDUSTRY; Changes in Technology and Labor Requirements, WPA, Washington, D. C.

CONNECTICUT CANALS, a reprint from the 54th Annual Report, Connecticut Society of Civil Engineers, New Haven, Conn.

A STATE SYSTEM OF PLANE COORDINATES, Bulletin No. 36, Co-ordinate Zones, Division of State Planning, Albany.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC., Proceedings of Sixteenth Annual Convention, 1938, French Lick, Ind.

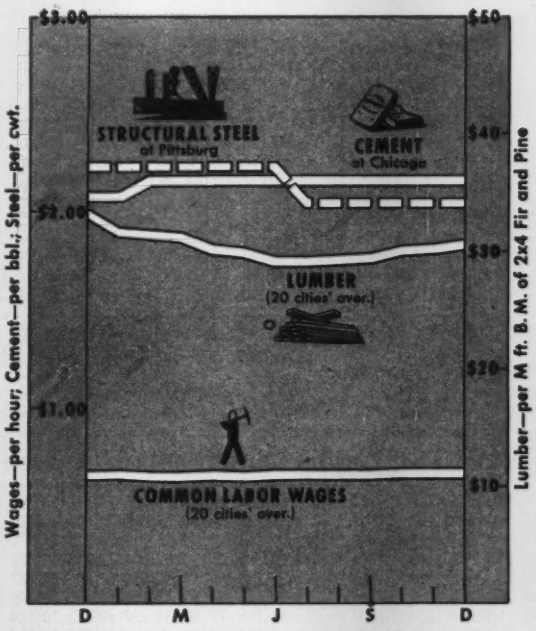
REPORT OF COMMITTEE, appointed Sept. 20, 1938 by the President of the United States to submit recommendations upon the general transportation situation, Pennsylvania Railroad Co., Philadelphia.

An Introduction To Construction Costs—1939 Edition

COST ESTIMATES, whether for designing, bidding or appraising, are a controlling factor in the conduct of the construction business. They govern planning, causing adoption or abandonment of a proposal; they guide bidding, fixing first who gets the job and last whether he makes a profit or a loss; and they determine the rates, charges and tolls for the facilities that they make possible. Cost data, in brief, constitute the one really universal language of the widely diversified construction industry.

In the following 70 pages, this importance of construction costs is given full emphasis. The guiding objective is to present the figures in useful and usable form. No attempt is made at interpretation, the collected data constituting a reference manual rather than a series of discussions in costs. Prior to last year, these cost data were published and sold separately in booklet form under the title of "Construction Costs". Now that the "cost book" is a part of the regular contents of *Engineering News-Record*, the data are available to every subscriber.

As an introduction to the detailed material that follows, a brief summary may be useful. The year 1938 was, on the whole, equal to or slightly better than 1937. Total volume of work was greater and costs were more steady, leveling off after the sustained rise that began in 1932. According to the *ENR* Construction Cost Index, an all-time peak in costs was reached in October, 1937, after which a slow decline occurred, stretching throughout the first half of 1938. A reduction in steel prices, fluctuating lumber prices and small increases in wage rates brought the index to 234.89 at the end of December, which compared with 241.05 twelve months earlier. In the companion *ENR* Building Cost Index, where skilled labor instead of common labor costs are reflected, a similar drop occurred, so that December, 1938, was 196.07 on the chart compared to 200.45 for December, 1937. The changes in both indexes resulted from the fact that reductions in the materials components exceeded increases in labor rates.



Changes during 1938 in wages and material prices that affected the *ENR* Construction Cost Index.

Wage rate increases for the most part occurred early in the year, after which relatively steady conditions prevailed. For unskilled workers the average rate paid in 20 representative cities was 67.8 cents per hour, compared with 64.5 cents during the previous year; comparable rates for skilled workers were $1.41 against $1.32. These are yearly averages. However, of more concern to current construction are the rates at the end of the year, which stood at record high levels: 68.2 cents for unskilled and $1.43 for skilled.

Despite some changes, prices of basic construction materials held remarkably steady during 1938. Structural steel shapes at Pittsburgh averaged $2.18 per hundred pounds for the year due to a drop from $2.25 to $2.10 in July. The year's average was 3 cents below 1937. Lumber fluctuated somewhat throughout the year, and the average price of $30.52 per 1,000 ft. board measure for 2x4-in. fir and pine in the 20 cities showed a 13 per cent drop from the 1937 average of $35.11. Common brick prices at New York rose from an average of $12.50 per thousand in 1937 to $13.10.

Cement was another one of the four basic commodities to show a price increase, rising in the New York market from an average of $2.07 per barrel in 1937 to $2.12 in 1938. During the year the price of cement varied from $2.05 in January to $1.95 in July, to $2.30 in August, to $2.15 in December. This is exclusive of bag costs.

Another element of construction costs is the cost of financing. Municipalities seeking funds through bond issues have enjoyed the lowest interest rates in history; during 1938 the average yield for high-grade municipal bonds was 2.91 per cent. Industrial companies and utilities, however, had to pay more for the use of money in 1938 than in 1937, although about the same rate prevailed as in the 1923-1929 period, namely about 5 per cent.

Another cost factor, particularly important to contractors, is the interest rate charged customers by banks in the principal cities. As charted elsewhere in this issue, such domestic money rates continue to be lowest in New York City and highest in southern and western cities, although all rates are considerably below the 20-year record.

ENR Construction Cost Index

THE *Engineering News-Record* Construction Cost Index has four components, (1) structural steel shapes at Pittsburgh; (2) cement at Chicago; (3) lumber, which until 1935 was 12 x 12 long leaf yellow pine wholesale at New York, and since 1935 is 2 x 4 S4S pine and fir in carload lots, *ENR* 20-cities average; (4) common labor, *ENR* 20-cities average of wage rates in force.

The weighting for the original price series is given in the following computation for the December, 1934 index:

Steel	25 cwt. x 1.80 =	45.00
Lumber	0.6 x 61.00 =	36.60
Cement	6 x 2.00 =	12.00
Labor	200 x .5413 =	108.26
Index		201.86

The weighting for the new lumber price series is 1.088, and the computation for January, 1939 index is:

Steel	25 cwt. x 2.0675 =	51.69
Lumber	1.088 x 30.78 =	33.49
Cement	6 x 2.19 =	13.14
Labor	200 x .682 =	136.40
Index		234.72

This Construction Cost Index is designed to predict changes in construction cost trends and to measure the movement of construction costs in general. It is not intended to apply to any specific class of construction or to a particular locality.

ENR Building Cost Index

In practice, the construction cost index has been used widely to apply

Engineering News-Record BUILDING Cost Index—1913 = 100

Yearly Average prior to 1922		1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935†	1936†	1937†	1938†	1939†
1913.. 100.00	J	147.12	168.20	189.30	182.70	184.25	187.80	185.90	190.00	190.30	180.70	150.60	140.82	160.15	166.50	168.25	185.45	198.62	196.24
1914.. 91.91	F	146.47	172.55	191.70	184.50	183.65	189.15	187.15	190.00	188.50	181.95	147.20	141.70	161.30	165.75	168.43	186.55	198.99	196.23
1915.. 95.28	M	145.19	178.40	194.10	184.50	184.25	187.30	187.15	190.00	189.20	180.19	145.88	140.80	161.70	164.10	169.68	187.65	199.29	196.46
1916.. 130.88	A	147.12	186.00	191.80	184.65	184.05	186.00	188.80	190.00	188.80	177.55	135.68	141.50	163.15	164.40	170.00	194.95	198.21	196.45
1917.. 166.79	M	149.02	188.90	192.48	182.80	183.55	185.40	190.10	191.25	187.90	174.55	136.38	143.85	168.15	163.30	170.25	197.15	197.86	.....
1918.. 159.10	J	149.77	191.30	187.65	183.00	181.80	185.75	187.55	191.95	185.40	172.45	137.58	143.20	168.15	164.85	170.18	199.20	198.22	.....
1919.. 158.77	J	150.85	191.40	184.50	180.20	184.30	183.88	187.55	191.95	183.25	170.45	139.48	144.30	169.15	165.25	170.85	199.80	194.39	.....
1920.. 207.23	A	154.55	191.50	183.25	183.00	185.10	186.50	187.55	192.75	183.65	163.10	139.40	145.90	168.40	166.20	173.93	200.65	194.49	.....
1921.. 166.05	S	164.15	192.20	181.35	180.50	185.10	184.60	187.55	191.55	182.40	159.50	139.60	154.50	170.10	166.05	174.33	200.62	194.80	.....
	O	167.75	191.00	178.35	181.75	187.95	186.60	187.55	190.30	181.80	159.50	140.00	157.05	170.20	167.30	175.33	201.00	195.48	.....
	N	167.08	192.35	176.50	182.35	187.95	184.98	188.00	190.30	181.80	158.30	139.50	159.00	170.20	167.30	175.50	200.30	195.58	.....
	D	169.10	188.00	178.38	183.05	187.95	185.10	190.00	190.30	181.80	154.95	140.00	160.70	170.20	167.15	179.30	200.45	196.07	.....
	Aver.	154.85	185.98	185.78	182.67	184.99	186.09	187.97	190.86	185.40	169.43	140.94	147.78	166.74	165.76	172.18	196.15	196.83	.....

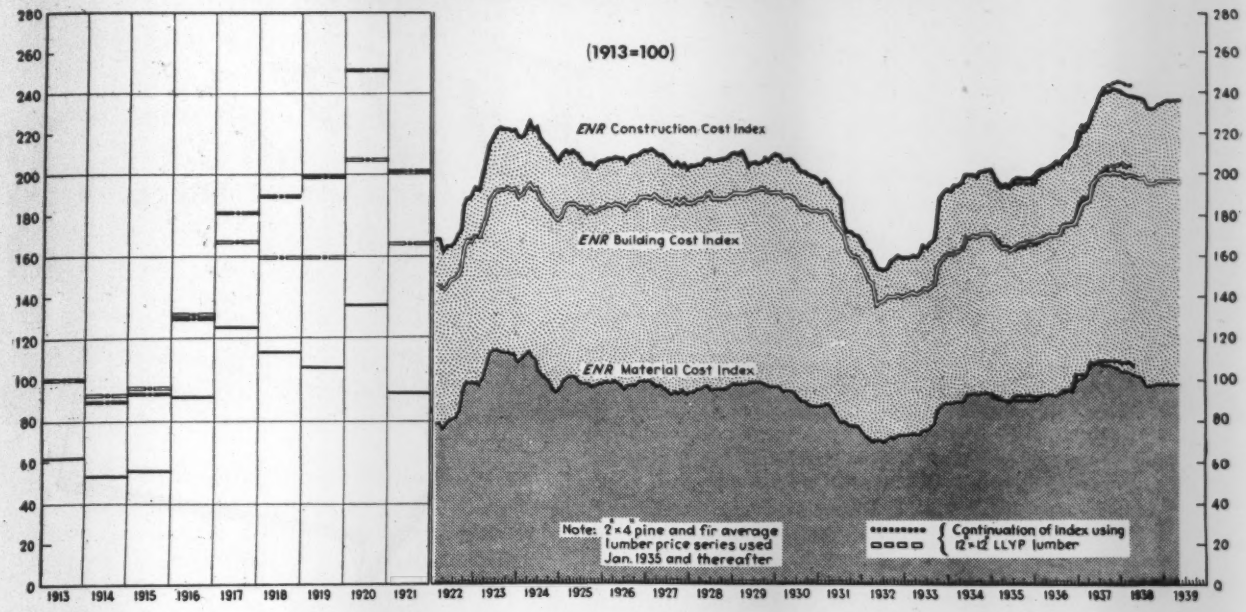
Engineering News-Record CONSTRUCTION Cost Index—1913 = 100

Yearly averages prior to 1914		1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
	J	89.22	87.12	112.66	167.75	184.51	198.05	206.55	2370.8	168.72	191.70	217.90	210.40	207.15	211.50	203.90	209.40	208.96
1903..... 93.90	F	89.22	87.36	116.66	167.75	184.51	201.50	225.10	230.67	168.72	197.40	220.30	209.70	206.55	210.15	204.65	210.40	206.46
1904..... 87.40	M	88.97	87.66	125.16	175.66	184.51	198.05	240.85	224.27	162.04	205.25	224.70	210.20	207.65	208.80	204.65	207.78	206.80
1905..... 90.55	A	87.97	90.16	129.51	183.41	186.01	191.25	265.20	213.07	164.72	213.50	221.60	209.55	207.05	209.00	206.40	203.40	207.12
1906..... 95.10	M	88.62	90.16	131.06	187.61	186.01	191.25	268.90	210.82	164.62	216.70	222.38	207.20	207.30	206.80	207.00	205.15	205.86
1907..... 100.55	J	87.87	88.96	128.71	199.26	186.31	191.85	273.80	209.82	166.62	220.70	216.85	204.60	204.80	205.55	206.15	205.65	203.36
1908..... 97.20	J	88.12	90.51	127.96	204.01	188.65	193.65	265.65	203.82	169.70	222.10	214.40	204.60	207.80	203.68	206.65	204.77	200.95
1909..... 90.92	A	90.11	91.76	128.76	198.41	193.85	196.65	252.00	193.47	173.40	221.50	213.15	204.60	208.30	205.50	207.29	205.91	200.95
1910..... 96.33	S	90.36	93.01	131.76	190.31	193.85	202.85	255.20	188.27	185.00	221.50	211.25	202.10	208.30	203.60	207.29	207.57	199.58
1911..... 93.43	O	88.51	96.16	135.11	167.11	193.85	202.25	255.20	182.57	188.60	220.30	207.55	205.35	209.80	204.40	207.71	206.32	198.72
1912..... 90.70	N	87.26	101.06	138.16	166.51	193.55	206.85	255.32	166.32	188.60	220.90	205.70	205.95	210.80	201.98	209.46	208.46	198.54
1913..... 100.00	D	86.51	107.06	149.41	167.11	194.75	206.85	251.62	167.82	192.60	217.30	208.58	205.95	210.80	203.90	210.16	209.46	196.86
	Aver.	88.56	92.58	129.58	181.24	189.20	198.42	251.28	201.81	174.45	214.07	215.36	206.68	208.03	206.24	206.78	207.02	202.85

Engineering News-Record CONSTRUCTION Cost Index—1926 = 100

Yearly averages prior to 1914			1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
	1926 = 100	J	42.9	41.9	54.2	80.6	88.7	95.2	99.3	110.0	81.1	92.2	104.7	101.1	99.6	101.7	98.0	100.6	100.4
		F	42.9	42.0	56.1	80.6	88.7	96.9	108.2	110.9	81.1	94.9	105.9	100.8	99.3	101.0	98.4	101.1	99.2
1903.....	45	M	42.8	42.1	60.3	84.4	88.7	95.2	115.8	107.8	77.9	98.7	180.0	101.0	99.8	100.3	98.4	99.9	99.5
1904.....	42	A	42.2	43.3	62.0	88.2	89.5	91.9	127.5	102.4	79.2	102.6	106.5	100.7	99.5	100.4	99.2	97.8	99.6
1905.....	43½	M	42.6	43.3	63.0	90.2	89.5	91.9	129.3	101.3	79.1	104.2	106.9	99.6	99.7	99.4	99.6	98.6	99.0
1906.....	46	J	42.2	42.7	61.9	95.8	89.5	92.2	131.6	100.9	80.1	106.1	104.3	98.4	98.5	98.8	99.1	98.9	97.8
1907.....	51	J	42.4	43.5	61.5	98.1	90.7	93.1	127.6	98.0	81.6	106.8	103.1	98.4	99.9	97.9	99.3	98.4	96.6
1908.....	47	A	43.3	44.1	62.0	95.4	93.2	94.5	121.1	93.0	83.4	106.5	102.4	98.4	100.1	98.8	99.6	99.0	96.6
1909.....	44	S	43.4	45.1	63.3	91.5	93.2	97.5	122.7	90.5	88.9	106.5	101.5	97.1	100.1	97.9	99.6	99.8	95.9
1910.....	46	O	42.5	46.2	64.8	80.3	93.2	97.2	122.7	87.8	90.7	105.9	99.8	98.7	100.9	98.3	99.8	99.2	95.5
1911.....	45	N	41.9	48.4	66.4	80.0	93.0	99.4	122.7	80.0	90.7	106.2	98.9	99.0	101.3	97.1	100.7	100.2	95.4
1912.....	43½	D	41.1	51.4	71.8	80.3	93.6	99.4	121.0	80.6	92.6	104.5	100.2	99.0	101.3	98.0	101.0	100.7	94.6
1913.....	48																		
		Aver.	42.5	44.5	62.2	87.1	90.9	95.3	120.8	97.0	83.8	102.9	103.5	99.4	100.0	99.1	99.4	99.5	97.5

ENR CONSTRUCTION COST INDEX—ENR BUILDING COST INDEX


(1913=100)
ENR Construction Cost Index
ENR Building Cost Index
ENR Material Cost Index
Note: 2×4 pine and fir average lumber price series used Jan. 1935 and thereafter
Continuation of index using 12×12 LLYP lumber

to building costs, and when common and skilled labor rates move in similar trends it is a satisfactory measure of relative building cost movement. However, following the low wage rates of 1932, common labor climbed much faster than skilled and reached new all-time highs by July, 1937. The increase was in the lower ranges between union and non-union. When "prevailing" wages became synonymous with union wages the gap closed up, hence the *ENR* 20-cities wage average increased more rapidly than the union rates.

To provide a more representative measure of building cost movement, the skilled labor trend has been substituted for the common labor trend in the *ENR* Construction Cost index, and the *ENR* Building Cost index computed. The labor weighting applied to the *ENR* skilled labor average for 20-cities thus becomes 68.38 hr., and the computation for the Jan. 1939 Building Cost Index is:

Steel	25 cwt. x	2.0675 =	51.69
Lumber	1.088 x	30.78 =	33.49
Cement	6 x	2.19 =	13.14
Labor	68.38 x	1.432 =	97.92
Index			196.24

* Superseded by figures in last four columns using 2 x 4 fir and pine lumber component.
† Based on 2 x 4 S4S fir and pine *ENR* 20 cities average lumber component instead of 12 x 12 yellow pine wholesale in New York used prior to 1935.
For fuller explanation of change in lumber component see page C-5 of June 30, 1938 *ENR*.

CONSTRUCTION Cost Index—1913 = 100

1931	1932	1933	1934	1935*	1936*	1937*	1935†	1936†	1937†	1938†	1939†	1940	
194.48	162.48	158.44	191.26	198.72	199.48	223.45	198.22	201.23	221.20	239.62	234.72	.....	J
196.61	161.82	159.30	194.06	196.02	201.20	223.45	195.07	201.33	222.05	238.99	234.31	.....	F
194.51	157.24	158.44	194.06	194.26	201.20	225.25	194.41	201.63	224.75	238.79	234.43	.....	M
191.63	153.12	160.16	195.86	194.50	202.20	230.25	194.65	202.80	231.35	237.95	234.86	.....	A
189.33	152.78	164.39	199.61	194.06	203.40	233.25	193.96	204.05	233.45	236.80	.....	.....	M
187.23	152.20	163.41	199.61	194.78	204.60	238.15	196.73	205.08	237.25	236.86	.....	.....	J
174.37	153.36	165.50	199.65	195.18	204.40	241.75	197.43	204.80	239.90	232.29	.....	.....	J
171.38	156.80	167.00	198.40	195.10	208.10	242.95	197.45	208.48	240.65	232.39	.....	.....	A
171.40	157.96	175.48	200.58	195.10	208.10	243.95	197.30	208.88	241.62	232.70	.....	.....	S
169.78	159.16	187.74	200.86	195.10	211.50	244.55	197.50	211.53	241.90	234.30	.....	.....	O
169.28	158.20	190.14	201.36	194.90	212.70	244.95	197.35	211.50	241.40	234.40	.....	.....	N
166.23	158.46	192.14	201.86	194.90	220.05	244.95	197.20	215.70	241.05	234.89	.....	.....	D
81.35	156.97	170.18	198.10	195.22	206.41	236.41	196.44	206.42	234.71	235.86	.....	.....	Aver.

CONSTRUCTION Cost Index—1926 = 100

1931	1932	1933	1934	1935*	1936*	1937*	1935†	1936†	1937†	1938†	1939†	1940	
93.5	78.1	76.2	91.9	95.5	95.9	107.41	95.3	96.7	106.2	114.9	112.9	.....	J
94.5	77.8	76.6	93.3	94.2	96.7	107.41	93.8	96.8	106.7	114.9	112.7	.....	F
93.5	75.6	76.2	93.3	93.4	96.7	108.18	93.5	96.9	108.0	114.8	112.7	.....	M
92.1	73.6	77.0	94.1	93.5	97.2	110.64	93.5	97.5	111.2	114.4	112.9	.....	A
91.0	73.4	79.0	95.9	93.3	97.8	112.08	93.2	98.2	112.0	113.8	.....	.....	M
90.0	73.2	78.5	95.9	93.6	98.4	114.48	94.6	98.5	113.8	113.9	.....	.....	J
83.8	73.7	79.6	96.0	93.8	98.3	116.21	94.9	98.4	115.1	111.7	.....	.....	J
82.4	75.4	80.3	95.4	93.8	100.0	116.78	94.9	100.2	115.7	111.7	.....	.....	A
82.4	75.9	84.4	96.4	93.8	100.0	117.27	94.9	100.4	115.9	111.9	.....	.....	S
81.6	76.5	90.2	96.6	93.8	101.7	117.55	95.0	101.5	116.1	112.7	.....	.....	O
81.4	76.0	91.4	96.8	93.7	102.2	117.75	94.9	101.5	115.8	112.7	.....	.....	N
79.9	76.2	92.4	97.0	93.7	105.8	117.75	94.8	103.4	115.7	112.9	.....	.....	D
87.1	75.4	81.8	95.2	93.8	99.2	113.63	94.4	99.2	112.7	113.3	.....	.....	Aver.

Base Conversion Table

To convert *ENR* Construction and Building Cost Indexes

From 1913 = 100 Base To	Divide 1913 = 100 Values By Const. Cost	Bldg. Index
1926=100	2.0803	1.8499
1929=100	2.0702	1.9086
1910–14=100	.9380	.....
1924=100	2.1536	1.8578
1923–25=100	2.1204	1.8481
1914=100	.8856	.9191
1911=100	.9343	.....

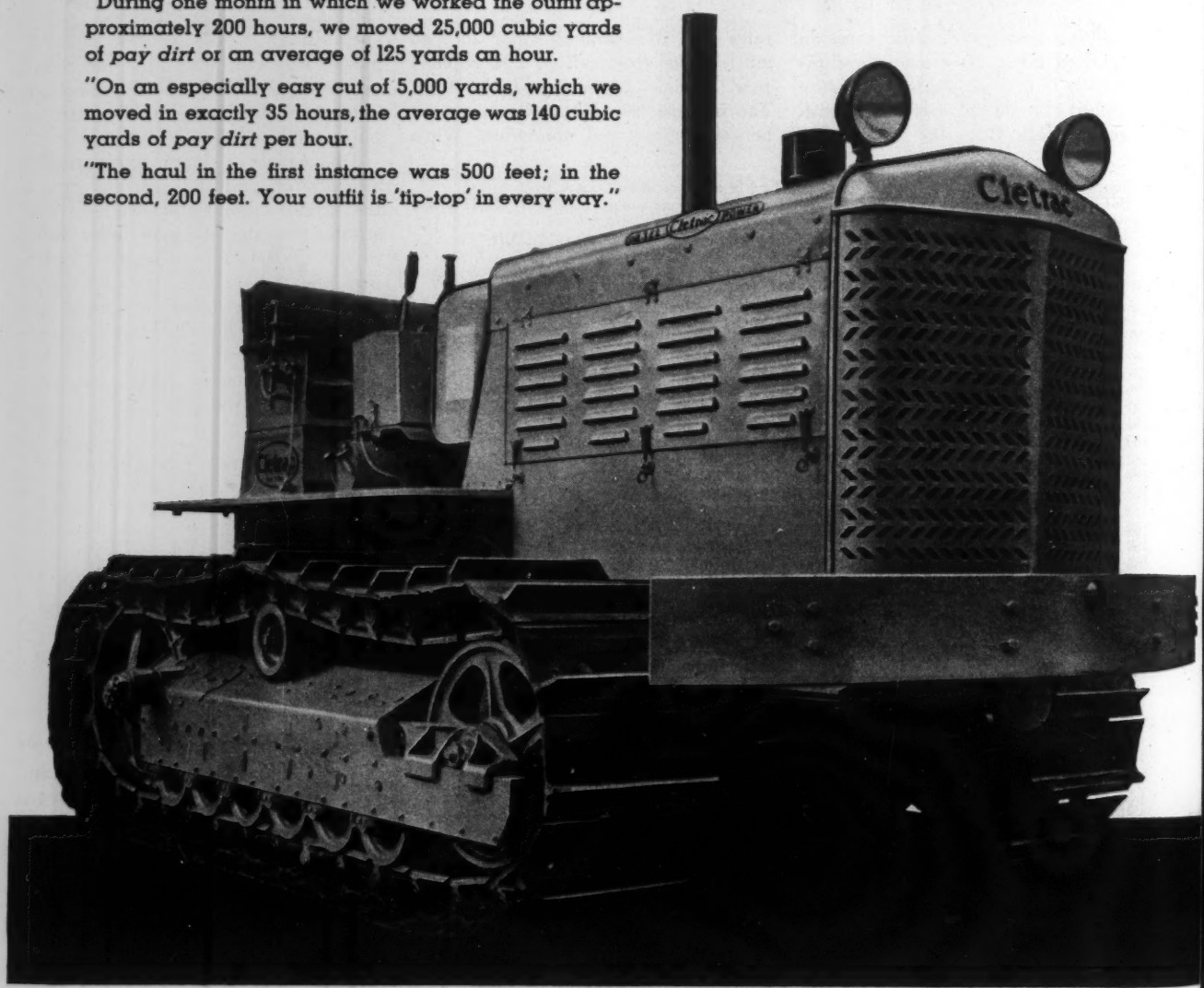
"TIP TOP" .. IN

"YOU'LL be interested in our experience with your Cletrac new Model F Diesel drawing a 12 yard hydraulic scraper," writes one Cletrac owner. (Name on request.)

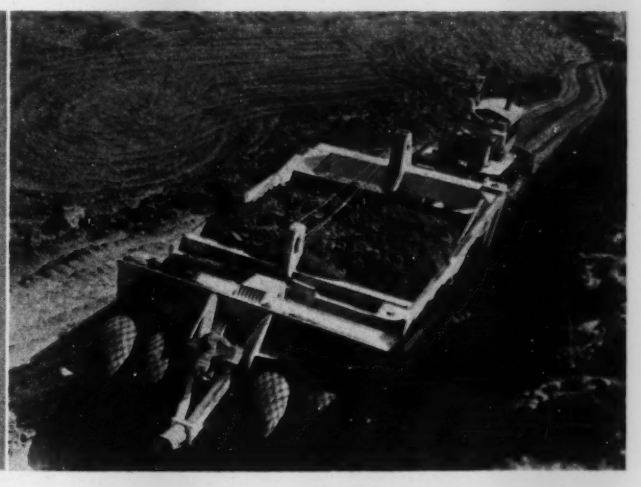
"During one month in which we worked the outfit approximately 200 hours, we moved 25,000 cubic yards of *pay dirt* or an average of 125 yards an hour.

"On an especially easy cut of 5,000 yards, which we moved in exactly 35 hours, the average was 140 cubic yards of *pay dirt* per hour.

"The haul in the first instance was 500 feet; in the second, 200 feet. Your outfit is 'tip-top' in every way."



EVERY WAY



This Cletrac Diesel of 95 h. p. handles a twelve yard scraper with ease. Fuel consumption is remarkably low.

WHETHER operating under "easy" conditions or "tough" going, every feature of Cletrac design and construction is planned to give "tip-top" performance every hour—every day.

With electric starting, for example, Cletracs are on the job faster in the morning.

Cletracs are properly balanced without unnecessary weight. The weight saving alone means as much as 19% greater pay load on a 30% grade.

Cletracs are "tip-top" for another reason—Controlled Differential Steering. This feature—exclusive with Cletrac—keeps both tracks pulling at all times. There's no loss of power by stopping one track. You handle larger loads on the turns... maneuver the tractor more easily... turn more smoothly.

It's Cletrac "tip-top" performance capacity, economy and dependability that keeps difficult jobs on schedule and earns bonuses on the easier ones.

Best of all, there's a Cletrac size and model from 14 to 95 horsepower—either gasoline or Diesel—to fit any job. You can choose the right size for your operations. Ask the nearest distributor for an on-the-job demonstration.

Cletracs do not "turn on a dime," but note the short turning radius through Controlled Differential Steering.

Two 94 h. p. Cletracs with bulldozers move full blades of dirt. Cletracs handle easily—are back for another load in a hurry.

THE CLEVELAND TRACTOR CO.
CLEVELAND, OHIO

Cletrac
REG. U.S. PAT. OFF.
Crawler Tractors
Built To Endure

14-95 HORSEPOWER · GASOLINE OR DIESEL

Special Building Cost Indexes

BUILDING COST INDEXES, reported here in both tabular and chart form, represent a variety of methods of measuring cost changes and trends.

Aberthaw Index—Computed by repricing, each quarter, a seven-story and basement reinforced concrete (62′ 4″ x 202′ 4″) building constructed in New England in 1914. Repricing is on same basis as though a construction bid were to be submitted to duplicate the original building. Current market prices for materials and bids from sub-contractors are obtained. Labor costs are based on current experience with similar construction.

American Appraisal Co. Index—Averages four types of buildings—wood frame; brick-wood frame; brick-steel frame; and reinforced concrete, based on a national average covering 30 cities. These indexes cover structural items only, and do not include factors for plumbing, heating, lighting and elevators. The index figures are calculated on the basis of normal average material prices, average labor wages, and the market conditions in thirty representative cities. They do not reflect extremes such as premium prices and over-time wages for rush work during boom periods or the "extreme low" of cut-throat practices during depressions. Reported monthly.

Associated General Contractors Index—Combines wages and materials in the proportion of 40 and 60 per cent respectively. Wages are prevailing rates paid for hod carriers and common labor, and prices are for sand, gravel, crushed stone, Portland cement, common brick, lumber, all weighted equally, hollow tile ⅓, and structural and reinforcing steel, together weighted ⅓. These wages and prices are reported by 12 district offices of the Associated General Contractors, from Atlanta, Baltimore, Boston, Chicago, Cincinnati, Cleveland, Detroit, Los Angeles, New York, Philadelphia, St. Louis and San Francisco. Reported monthly.

Boeckh Index—(see table on accompanying page). Computed by E. H. Boeckh & Associates, Inc., Cincinnati, O., as of the first of each month, from basic cost data on materials obtained for most part from local building trade papers. Prevailing wage rates are obtained from contractors. Actual rather than nominal rates for both skilled and common labor are used. An arbitrary labor efficiency correction is used, based on study of labor conditions in each area. Weights are based on studies of actual building costs, and vary with the different types of structures. Reported monthly.

Fruin-Colnon Index—Represents building index number for St. Louis, determined by this contractor's actual and estimated costs of material and labor on an industrial plant consisting of five buildings in St. Louis.

George A. Fuller Index—Based on composite of three commercial type buildings, 1913 = 100. Index computed by repricing 36 major cost elements including mechanicals, elevators, wiring, heating and ventilating. Computed periodically.

Turner Index—Compiled by Turner Construction Co., New York for eastern cities, is based on actual costs encountered on its own building construction work. These factors are considered: labor rates; materials prices; productivity of labor; efficiency of plant and management; competitive conditions. Computed periodically.

Tuttle Index—Represents costs of general building, both industrial and architectural, in the East. This index was not computed from June, 1933 until Feb. 1934. It was resumed Mar. 1, 1934 by re-computing cost of 1932 building on basis of 1934 cost experience, and determining relative

American Appraisal Company Construction Cost Trend Index — 1913 = 100

For average of four types of buildings: all Frame, Brick Wood Frame, Brick Steel Frame and Reinforced Concrete.

These indices cover structural items only, and do not include factors for Plumbing, Heating, Lighting, Elevators, etc.

	1913	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38
U. S. AVERAGE (30 Cities)	**100**	**98**	**101**	**116**	**144**	**172**	**213**	**270**	**205**	**189**	**212**	**210**	**203**	**206**	**206**	**205**	**206**	**199**	**171**	**152**	**146**	**157**	**157**	**163**	**181**	**182**
BOSTON	100	100	103	118	149	176	214	270	208	196	218	215	211	210	208	209	211	212	187	164	159	165	164	169	192	190
NEW YORK	100	99	100	115	142	167	204	277	227	203	228	223	214	217	218	218	220	219	190	164	161	169	168	172	189	192
BUFFALO	100	98	99	115	144	173	211	260	196	184	214	211	204	205	203	200	199	194	171	152	146	154	153	157	182	185
BALTIMORE	100	97	99	116	150	187	222	274	204	196	222	208	215	212	214	216	217	209	178	162	154	163	169	174	185	184
PHILADELPHIA	100	98	102	115	145	176	220	286	210	191	221	218	213	214	215	215	216	204	179	158	153	162	161	164	178	178
PITTSBURGH	100	96	99	115	142	172	213	273	208	192	215	224	220	222	223	222	222	215	191	168	156	165	163	169	192	199
CINCINNATI	100	98	100	115	143	167	202	262	201	184	210	209	208	208	208	207	209	198	169	153	147	157	158	167	190	192
CLEVELAND	100	97	99	120	149	174	217	288	216	200	229	231	224	222	219	220	220	215	183	156	147	160	162	169	193	191
CHICAGO	100	97	100	116	141	165	209	280	216	193	217	212	212	209	211	211	211	207	180	158	152	162	165	173	188	190
INDIANAPOLIS	100	102	104	119	146	170	206	266	210	192	215	216	212	209	212	214	213	208	177	153	148	157	157	162	184	189
DETROIT	100	99	102	122	150	181	227	288	209	190	215	215	214	213	210	209	208	202	167	145	143	153	156	162	187	189
MILWAUKEE	100	100	103	120	150	173	221	276	202	186	214	213	207	207	208	209	208	196	158	141	137	152	159	171	192	193
MINNEAPOLIS	100	98	100	114	142	166	202	264	200	184	203	198	191	187	188	188	188	182	159	145	143	149	150	156	183	186
KANSAS CITY	100	98	102	120	150	175	215	260	205	196	215	212	205	204	200	198	198	191	169	151	144	155	157	160	181	187
ST. LOUIS	100	97	100	114	141	168	207	265	210	190	214	222	217	215	211	210	209	204	180	157	151	160	158	162	186	186
ATLANTA	100	97	98	111	140	180	231	287	206	190	213	204	198	200	202	203	204	191	166	142	138	157	159	163	177	169
DALLAS	100	100	105	121	145	171	213	261	199	183	200	197	190	195	195	194	193	186	163	143	136	145	145	148	159	157
NEW ORLEANS	100	96	96	112	136	169	224	269	207	192	215	216	206	207	208	206	206	195	161	142	138	155	155	160	173	175
DENVER	100	100	102	118	144	165	201	248	195	181	192	196	194	193	187	194	196	190	162	145	138	146	147	151	175	178
SEATTLE	100	96	101	115	141	171	209	254	188	179	198	196	192	189	185	185	188	181	154	138	133	146	150	155	179	179
SAN FRANCISCO	100	97	104	118	139	164	201	246	195	181	199	190	186	179	179	179	182	178	154	141	135	141	141	151	166	164
LOS ANGELES	100	97	102	112	133	159	201	242	200	191	205	196	189	188	186	186	189	176	153	139	132	138	137	139	156	156

NOTE.— These construction cost index figures are based on 1913 as 100% for each individual location, thus indicating the trend in each city and not the trend between the various locations. The index figures are calculated on the basis of normal average material prices, average labor wages, and the market conditions in the individual cities and do not reflect extremes such as premium prices and overtime wages for rush work during boom periods or the "extreme low" of cut throat practices during the "depression periods."

change in cost. It is re-computed periodically as warranted.

Cummins Constr. Corp. (Known as *Consolidated Engineering Co. Index* prior to 1938.) Composite index of construction costs in Baltimore of closed shop and of open shop building contractors. In Baltimore 90 per cent of the contractors work on an open shop basis and do about 80 per cent of the construction business. The index is a composite of all types of buildings. The labor component fluctuates with supply and demand in the open shop work, and the predominance of this class of work causes a greater fluctuation in the composite index than if closed shop predominated with fixed wages for contract periods. This index was established in 1911. Values prior to 1913 are listed in the following tabulation:

1860-1880 = 63 1900-1913 = 87.5
1880-1900 = 70 1900 = 75.1

1901	76.3	1905	85.6	1909	93.4
1902	79.2	1906	92.4	1910	99.0
1903	81.6	1907	96.7	1911	96.9
1904	82.1	1908	91.3	1912	97.6

Values are computed monthly.

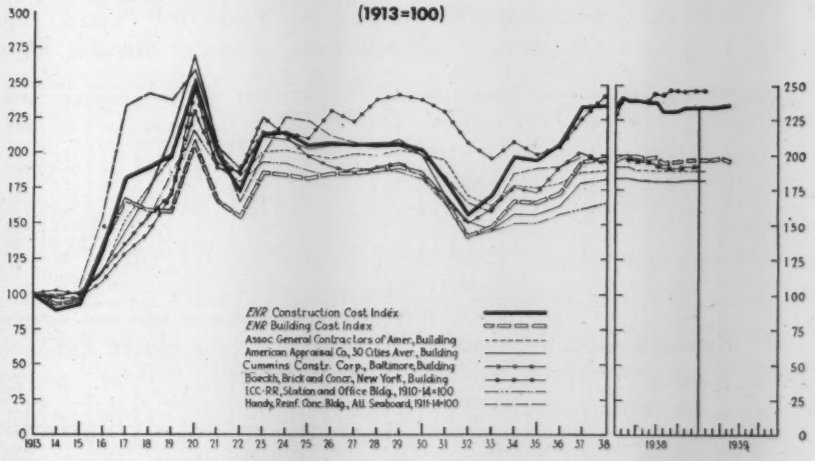
Handy Public Utility Index—Compiled by Whitman, Requardt and Smith, consulting engineers, Baltimore, for 5 geographic divisions of the United States. First published in *Electrical World*, April 14, 1923 and *Gas Age Record*, Oct. 13, 1923. Prices of basic materials: cement, sand, stone, cast iron pipe, wire, are obtained from *Engineering News-Record, Iron Age* and other sources, and checked where possible against prices actually paid. Labor cost trends are from such sources as U. S. Department of Labor and National Association of Builders Exchanges. Mechanical and electrical equipment prices and trends are from nationally known manufacturers. These prices of materials, labor and equipment are reduced to indexes, 1911 = 100. Items of more recent development are based upon a later year. Proportions of basic materials, labor and equipment, determined by analyses of many millions of dollars' worth of plant and construction, develop the weights applied to materials, labor and equipment indexes to obtain the composite indexes reported. Computed January 1 and July 1.

Building Cost Indexes

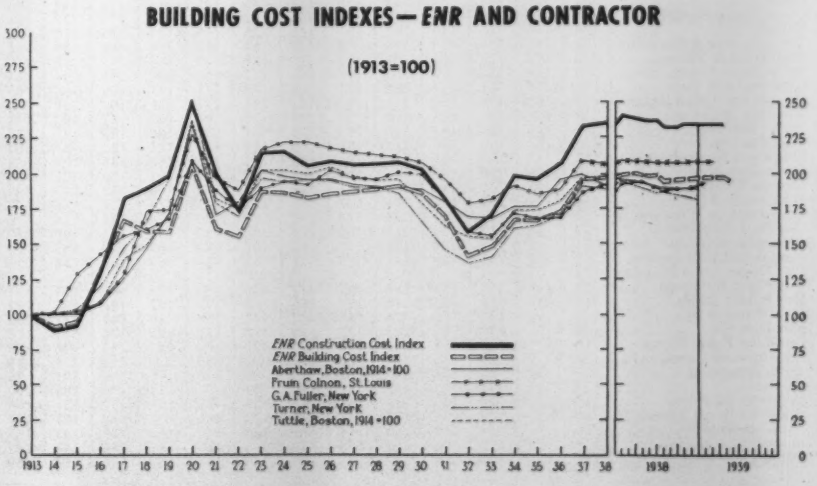
Year	AGC	Boeckh New York*	Cummins Constr.	Aber-thaw	Fruin-Colnon	Fuller	Turner	Tuttle
1913	100	100	100	.....	100	100	100	.....
1914	99	102	97.7	100	100	101.5	100	100
1915	100	99	97.7	100	102	129.5	103	100
1916	114	116	108.1	107	108	143	120	108
1917	152	135	128.1	126	128	156	147	139
1918	175	155	143.1	147	173	160	166	149
1919	198	171	170.8	172	174	168	196	172
1920	247	230	247.1	234	227	209	252	237
1921	200	193	189.0	170	197	188	183	179
1922	184	186.5	187.1	179	188	175	175	170
1923	201	215	226.7	202	217	190	196	202
1924	202	215	213.8	198	223	194	194	202
1925	199	211	198.5	195	222	193	195	200
1926	197	230	191.6	196	218	202	195	204
1927	200	223	186.6	193	214	197	190	198
1928	199	238	190.3	191	213	196	190	195
1929	203	242	194.8	189	211	201	185	196
1930	200	238	184.7	188	207	199	165	178
1931	196	230	170.9	179	196	180	145	162
1932	171	208	150.8	169	178	157	136	155
1933	163	197	160.9	168	181	155	140	153.5
1934	178	209	176.6	176	191	171	160	173
1935	176	200	173.0	176.5	185	167	162	173
1936	179	205	191.7	195	187.5	168	169	180
1937	188	226	202.8	199.4	210	186.5	192	198.5
1938	189	243	193.8	191.1	207	192.1	188	.....

*Brick and concrete building, New York, series converted to 1913=100.

BUILDING COST INDEXES—*ENR*—COMPOSITE AND ENGINEERING

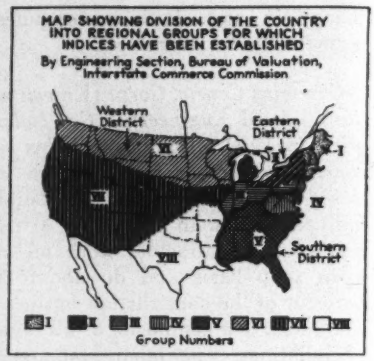

(1913=100)
ENR Construction Cost Index
ENR Building Cost Index
Assoc General Contractors of Amer., Building
American Appraisal Co., 30 Cities Aver., Building
Cummins Constr. Corp., Baltimore, Building
Boeckh, Brick and Concr., New York, Building
ICC-RR, Station and Office Bldg., 1910-14=100
Handy, Reinf. Conc. Bldg., All Seaboard, 1911-14=100
1938
1939

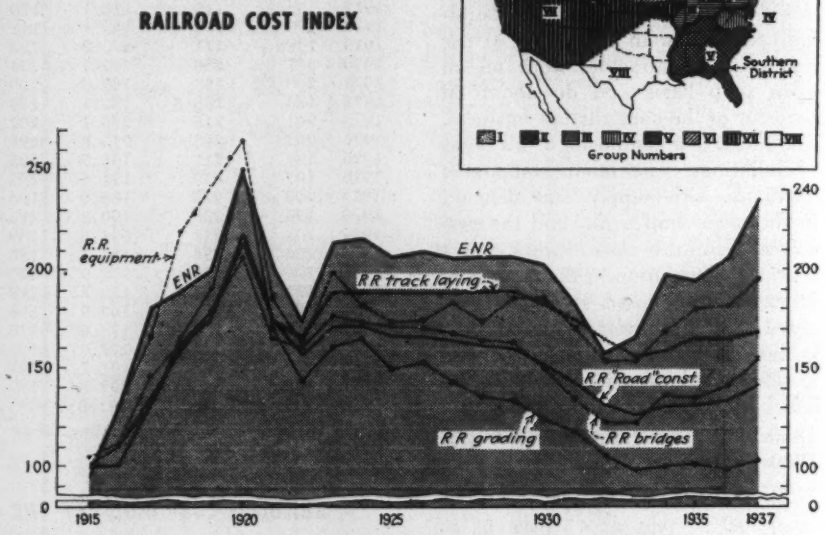
BUILDING COST INDEXES—*ENR* AND CONTRACTOR



Railroad Construction Cost Indexes

THESE indexes by Engineering Section, Bureau of Valuation, Interstate Commerce Commission, include items such as grading, tunnel excavation, bridges, ballast haul, track-laying and surfacing, developed from analysis of major construction contracts over a period of 30 years. Indexes for material accounts such as ties, rails, other track material, ballast and fences are based on studies of carriers' returns to Valuation Order 14, joint studies made with various sub-committees of Presidents' Conference Committee, well-known engineering and trade publications, contracts covering major construction projects over a period of 30 years, and other information furnished by individual carriers.





Railroad Cost Indexes for Regions by Years for "Load" Construction — 1910-14 = 100

Total of Accounts 1-46, ROAD, Engineering Section, Bureau of Valuation, Interstate Commerce Commission, July 1, 1938

United States	Per Cent	Index by Years 1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Reg. I to VIII...	**73.09**	**110**	**134**	**159**	**178**	**214**	**175**	**157**	**171**	**171**	**166**	**166**	**164**	**161**	**160**	**152**	**143**	**131**	**127**	**131**	**131**	**133**	**142**
Reg. I.....	75.36	112	138	162	184	220	178	163	177	178	172	173	171	167	166	158	146	134	131	133	134	136	146
Reg. II.....	68.15	111	134	160	180	214	176	160	174	174	168	168	167	165	164	157	145	133	130	134	134	136	146
Reg. III.....	67.99	111	135	160	180	214	176	160	173	173	169	168	167	164	163	155	143	132	129	133	133	136	146
Reg. IV.....	70.49	110	132	157	180	214	173	152	167	166	164	163	159	155	154	145	133	126	122	125	126	127	137
Reg. V.....	76.66	109	133	158	179	218	171	153	168	167	163	164	160	156	156	148	137	129	125	129	128	131	141
Reg. VI.....	77.41	110	133	157	177	215	175	155	169	170	163	164	162	158	158	150	138	129	125	128	128	129	139
Reg. VII.....	75.62	109	131	157	175	212	177	158	170	170	165	166	163	160	158	151	139	131	128	130	129	131	140
Reg. VIII.....	78.15	109	133	160	176	208	173	157	171	171	166	167	164	161	161	154	143	133	130	133	134	135	144

(Indexes represent territorial index factors and are not necessarily applicable for determining unit reproduction costs upon individual roads.)

Railroad Cost Indexes by Accounts Applicable to Entire U. S., Regions I to VIII, Incl.

"Road" Construction	1916	'17	'18	'19	'20	'21	'22	'23	'24	'25	'26	'27	'28	'29	'30	'31	'32	'33	'34	'35	'36	'37
Engineering.....	110	134	159	178	214	175	157	171	171	166	166	164	161	160	152	143	131	127	131	131	133	142
Grading.....	110	130	165	190	250	170	143	160	164	149	153	143	135	133	123	118	106	98	100	101	99	103
Undergr'd Power Tubes..																						
Tunnels and Subways....	109	128	150	183	208	179	165	179	179	179	178	169	155	155	143	130	119	111	122	120	130	139
Bridges, Culverts, etc....	111	146	162	178	206	165	160	176	173	171	170	168	164	163	150	134	122	122	136	135	141	155
Elevated Structures.....	124	169	177	184	210	150	153	173	171	168	165	163	163	162	154	144	129	122	136	136	137	158
Ties.....	100	112	133	170	201	189	157	177	175	172	173	175	176	175	170	155	144	139	149	147	150	159
Rails.....	106	121	148	152	168	158	144	145	145	144	144	144	144	144	144	144	140	134	123	123	124	143
Other Track Material....	129	198	210	203	209	192	161	182	179	177	177	177	177	170	169	165	163	158	150	147	150	169
Ballast.....	107	114	140	150	207	191	176	175	175	174	175	176	176	176	168	159	146	146	141	139	140	143
Track Laying & Surfacing.	100	130	163	175	218	174	165	188	188	188	188	188	188	188	182	175	164	157	159	165	165	169
Right-of-way Fences.....	122	142	178	194	204	189	177	179	179	176	175	175	175	173	171	164	147	135	140	140	138	143
Snow, Sand Fences, Sheds.	108	119	165	199	280	197	194	212	200	201	201	204	204	204	198	188	125	126	140	140	140	155
Crossings and Signs.....	108	137	161	182	208	171	164	178	175	171	169	166	165	165	161	153	131	127	139	137	139	152
Station and Office Bldgs..	115	135	154	185	215	192	180	194	193	188	184	189	188	187	182	165	141	145	151	151	157	166
Roadway Buildings.....	115	136	156	185	216	192	178	196	196	189	187	192	191	190	186	166	140	145	150	150	150	162
Water Stations.....	120	159	170	191	213	185	178	187	187	186	182	185	186	184	177	161	147	151	155	155	156	166
Fuel Stations.....	120	153	160	190	212	181	166	185	185	182	180	183	183	183	174	159	144	149	154	154	153	159
Shops and Enginehouses..	118	141	159	188	216	191	180	193	192	188	185	189	188	187	176	161	137	142	147	147	155	165
Grain Elevators.....	110	128	150	185	214	190	184	197	197	193	190	195	193	193	182	165	137	142	147	147	156	164
Storage Warehouses.....	115	135	155	185	210	193	178	198	198	193	189	193	191	191	184	165	137	142	147	147	154	166
Wharves and Docks.....	114	133	152	178	204	167	158	175	175	174	177	178	178	178	172	158	136	141	146	146	149	153
Coal and Ore Wharves...	117	145	155	184	204	170	159	176	176	174	174	176	176	176	172	157	136	142	147	147	151	153
Gas Producing Plants....	122	148	175	194	213	194	176	188	189	186	185	188	189	189	178	163	145	148	179	179	178	178
Telegraph & Teleph. Lns.	124	147	158	164	192	191	162	187	179	163	157	163	165	165	150	138	121	119	125	131	131	135
Signals and Interlockers..	106	132	152	165	175	163	158	165	164	162	169	158	155	154	147	138	130	130	133	136	138	143
Pwr Dams, Cnls, Pipe Lns																					151	149
Pwr Plant Buildings.....	122	141	158	189	218	197	184	196	196	191	186	191	191	189	177	162	138	143	148	148	152	167
Pwr Substa Bldgs.....	117	137	156	187	218	194	180	197	197	192	188	193	191	190	176	161	137	142	147	147	138	164
Pwr Transmn Sys.....	166	190	181	186	176	145	132	142	136	140	141	137	142	150	136	116	98	98	103	105	108	123
Pwr Dist Sys.....	148	178	192	189	205	172	163	178	172	175	176	175	178	181	173	148	144	144	148	151	152	155
Pwr Line Poles, Fixtrs....	116	145	169	194	230	208	179	209	203	185	183	198	199	209	200	172	147	147	150	153	148	157
Underground Conduits...	110	119	172	206	250	228	214	220	215	220	216	219	219	217	215	175	175	175	180	184	185	185
Misc. Structures.....	117	137	156	186	217	192	179	195	195	190	186	191	190	189	182	164	141	146	151	151	154	161
Paving.....	124	153	177	205	217	191	190	191	191	191	190	190	190	190	190	181	156	150	145	145	145	150
Roadway Machines.....	113	127	146	158	170	162	149	151	151	151	151	151	149	148	147	144	138	138	147	147	147	161
Roadway Small Tools....	100	179	179	184	202	181	170	173	185	190	190	191	191	190	160	155	155	150	150	150	160	170
Shop Machinery.....	126	155	192	200	210	198	173	183	185	185	186	187	189	191	176	166	155	155	179	179	179	198
Power Plant Machinery...	126	155	192	200	210	198	173	183	185	185	186	187	189	191	176	166	155	155	179	179	193	206
Power Substation Appar..	126	155	192	200	210	198	173	183	185	185	186	187	189	191	176	166	155	155	179	179	145	149

YOUNGSTOWN STEEL PIPE FOR WATER MAINS

Lasts Longer, Assures Greater Flow, Reduces Costs

You engineers who want the most value for your city, will welcome these facts about Youngstown Steel Pipe for water mains --

1 - Long life. Wrapped and coated to resist time itself.

2 - Lined with plastic enamel which prevents encrustation, tuberculation and corrosion. Results in initial and sustained flow capacities never before approached.

3 - This smooth glass lining offers minimum resistance to flow, reduces friction head and so cuts pumping cost throughout the years.

4 - Youngstown Steel Pipe costs far less to lay; longer lengths -- fewer joints -- coupled above ground -- narrow trench -- no bellholes -- no dewatering of trench--less weight--reduced transportation and hauling costs.

5 - Has high resistance to water hammer shock, impact, and traffic vibration.

Many cities, utilities and industries know from experience the savings Youngstown Steel Pipe assures. Specify YOUNGSTOWN and give your city complete satisfaction and lower water costs.

THE YOUNGSTOWN SHEET AND TUBE COMPANY
Manufacturers of Carbon and Alloy Steels
General Offices - YOUNGSTOWN, OHIO

Tradition is no substitute for scientific facts

Steel Pipe for Water Mains
Tubular Products
Sheets - Plates - Conduit - Tin Plate - Bars
Rods - Wire - Nails - Unions
Tie Plates and Spikes.
1-4A

PUBLIC UTILITY CONSTRUCTION COST INDEX

Compiled and published by Whitman, Requardt and Smith, Consulting Engineers, Baltimore, Md., for the Estate of William W. Handy

Table No. 1 Cost Trends of Building Construction, 1911 to 1914 = 100

(Complete Index reports 13 items entering into Building Construction Costs)

COST INDEX NUMBERS

Classes of Construction Material and Labor Elements	1911	1912	1913	1914	1915	1916	1917	1918	Jan. 1 1919	Jan. 1 1920	July 1 1920	Nov. 1 1920	Jan. 1 1921	Sept. 1 1921	Feb. 1 1922	Jan. 1 1923	Jan. 1 1924	July 1 1924	Jan. 1 1925	July 1 1925	Jan. 1 1926	July 1 1926	Jan. 1 1927	July 1 1927	Jan. 1 1928	July 1 1928	Jan. 1 1929	July 1 1929	Jan. 1 1930	July 1 1930	Jan. 1 1931	July 1 1931	Jan. 1 1932	July 1 1932	Jan. 1 1933	July 1 1933	Jan. 1 1934	July 1 1934	Jan. 1 1935	July 1 1935	Jan. 1 1936	July 1 1936	Jan. 1 1937	July 1 1937	Jan. 1 1938	July 1 1938	Jan. 1 1939
Atlantic Seaboard Division																																															
Reinforced Concrete	100	107	120	153	233	242	237	238	274	269	233	182	165	199	227	224	221	216	213	213	214	203	204	206	209	212	205	194	189	179	171	159	153	165	178	194	191	189	191	192	199	216	214	206	206	
Brick	100	107	120	141	192	212	220	246	279	278	245	207	188	215	237	232	230	229	228	229	230	223	224	217	219	220	212	207	203	194	189	173	166	175	189	200	195	194	197	197	203	218	217	211	211	
North Central Division																																															
Reinforced Concrete	100	107	120	153	230	230	220	220	270	263	228	181	163	193	219	214	212	208	203	201	206	194	195	197	200	203	199	190	185	177	169	154	151	162	175	186	182	182	186	187	196	206	209	200	200	
Brick	100	107	120	140	189	198	199	224	272	269	238	201	181	206	225	218	216	215	212	211	214	206	209	201	203	205	199	195	192	186	181	164	161	170	183	190	185	184	188	189	197	207	208	203	203	
South Central Division																																															
Reinforced Concrete	100	107	120	155	232	236	224	224	268	263	229	181	160	191	213	206	203	196	192	191	194	186	186	188	191	193	187	179	176	169	149	144	140	148	160	173	179	173	175	177	187	200	198	189	188	
Brick	100	107	120	142	191	204	203	228	271	270	240	224	181	206	221	211	208	205	203	204	205	201	202	195	197	198	190	185	183	168	160	154	151	157	171	179	182	175	178	180	186	198	197	191	191	
Plateau Division																																															
Reinforced Concrete	100	107	120	151	232	234	221	220	260	256	221	181	164	192	215	206	208	201	196	197	199	188	189	191	194	196	190	180	177	166	153	149	146	156	168	178	174	172	176	180	188	206	203	194	194	
Brick	100	107	120	139	191	203	202	228	284	284	232	203	185	207	223	214	214	211	211	211	210	211	205	205	199	200	201	193	187	184	175	167	163	160	168	182	187	182	181	182	185	191	206	204	199	199
Pacific Division																																														
Reinforced Concrete	100	107	120	151	230	233	220	225	266	259	226	187	165	191	212	205	203	196	191	190	196	185	185	188	191	194	188	178	175	165	157	148	145	153	166	177	174	173	175	178	186	200	199	192	192	
Brick	100	107	120	138	189	201	199	229	288	285	234	207	185	204	217	206	205	201	198	197	203	197	197	190	192	194	188	180	177	169	164	156	154	156	170	177	172	173	176	179	185	198	197	193	193	

Table No. 2 Cost Trends of Gas Plant Construction, 1911 = 100

(Complete Index reports 17 items entering into Gas Plant Construction Costs)

COST INDEX NUMBERS

A, below, relates to Total Constr. & Equip; B relates to Mech. Equip. Excl. of Gas Holders	1911	1912	1913	1914	1915	1916	1917	1918	Jan. 1 1919	July 1 1920	Jan. 1 1920	Sept. 1 1921	Jan. 1 1923	Jan. 1 1924	July 1 1924	Jan. 1 1925	July 1 1925	Jan. 1 1926	July 1 1926	Jan. 1 1927	July 1 1927	Jan. 1 1928	July 1 1928	Jan. 1 1929	July 1 1929	Jan. 1 1930	July 1 1930	Jan. 1 1931	July 1 1931	Jan. 1 1932	July 1 1932	Jan. 1 1933	July 1 1933	Jan. 1 1934	July 1 1934	Jan. 1 1935	July 1 1935	Jan. 1 1936	July 1 1936	Jan. 1 1937	July 1 1937	Jan. 1 1938	July 1 1938	Jan. 1 1939
Atlantic Seaboard Division																																															
A	100	107	112	136	186	229	239	253	279	265	205	224	211	238	234	228	230	230	226	223	215	216	216	219	218	218	214	206	202	188	176	178	189	216	216	217	218	218	225	246	246	244	241			
B	100	104	108	138	195	233	213	222	241	248	211	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274			
North Central Division																																															
A	100	102	109	131	180	203	210	221	257	248	201	206	226	224	220	217	217	218	214	211	204	205	204	206	207	208	207	203	198	178	182	185	196	203	202	203	206	206	219	235	237	235	232			
B	100	104	108	138	195	233	219	222	241	248	201	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274			
South Central Division																																															
A	100	102	114	145	182	213	214	223	251	246	203	196	214	210	205	199	199	200	198	195	187	187	187	190	188	187	185	177	171	160	158	167	177	184	195	196	202	202	208	223	222	219	216			
B	100	104	108	138	195	233	219	222	241	248	201	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274			
Plateau Division																																															
A	100	103	107	128	180	207	207	214	234	231	194	193	210	206	206	201	202	202	198	196	187	189	189	191	189	188	186	181	176	166	170	173	184	191	190	190	195	195	202	221	221	220	216			
B	100	104	108	138	195	233	219	222	241	248	201	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274			
Pacific Division																																														
A	100	104	102	107	128	180	207	209	228	255	248	212	203	219	215	211	206	205	206	206	203	196	197	197	201	200	198	197	191	187	177	180	178	189	196	195	197	198	203	210	228	228	230	227		
B	100	104	108	138	195	233	219	222	241	248	201	194	220	218	217	213	212	212	216	211	208	209	213	221	224	222	219	217	209	195	192	199	216	230	232	234	240	240	252	277	277	274	274			

Table No. 3 Cost Trends of Electric Light and Power Construction, 1911 = 100

(Complete Index reports 50 items entering into Electric Light and Power Construction Costs)

COST INDEX NUMBERS

Classes of Constr. Material, Equipment and Labor Elements	1911	1912	1913	1914	1915	1916	1917	1918	Jan. 1 1919	Jan. 1 1920	July 1 1920	Sept. 1 1921	Jan. 1 1923	Jan. 1 1924	July 1 1924	Jan. 1 1925	July 1 1925	Jan. 1 1926	July 1 1926	Jan. 1 1927	July 1 1927	Jan. 1 1928	July 1 1928	Jan. 1 1929	July 1 1929	Jan. 1 1930	July 1 1930	Jan. 1 1931	July 1 1931	Jan. 1 1932	July 1 1932	Jan. 1 1933	July 1 1933	Jan. 1 1934	July 1 1934	Jan. 1 1935	July 1 1935	Jan. 1 1936	July 1 1936	Jan. 1 1937	July 1 1937	Jan. 1 1938	July 1 1938	Jan. 1 1939
Atlantic Seaboard Division																																															
Total Construction and Equip	100	106	116	132	160	192	202	208	226	221	183	189	201	196	201	197	197	194	193	187	192	192	195	206	204	188	191	186	182	176	170	177	186	200	200	199	204	205	213	230	226	222	224			
Electric Plant — Steam	100	106	119	132	160	187	196	206	216	194	186	196	192	199	196	197	196	194	190	193	192	200	208	206	198	195	192	186	186	200	205	204	205	206	210	229	226	223	225							
Sub-Station Equip	100	105	111	130	161	178	175	197	201	182	176	187	186	191	190	184	178	176	172	173	173	170	181	179	174	177	175	172	168	165	168	172	184	184	184	185	187	188	204	204	203	203				
North Central Division																																														
Total Construction and Equip	100	105	129	154	178	184	189	214	210	176	179	193	189	194	192	190	187	187	182	186	186	189	190	199	184	188	187	186	174	172	179	187	195	195	194	199	199	209	224	222	216	219				
Electric Plant — Steam	100	102	112	123	145	163	172	188	197	179	171	185	185	189	189	189	188	188	185	188	187	195	202	203	195	197	199	199	188	186	189	203	204	203	202	204	204	205	209	227	225	222	224			
Sub-Station Equip	100	102	104	122	145	156	151	180	184	167	162	178	179	182	184	178	171	171	168	169	169	167	177	176	172	177	179	181	169	169	171	176	184	184	184	184	184	187	204	203	202	203				
South Central Division																																														
Total Construction and Equip	100	107	130	157	183	188	193	218	216	183	182	193	186	189	186	184	183	182	179	183	186	189	196	197	185	186	183	179	171	169	179	187	195	198	193	199	201	208	224	221	216	218				
Electric Plant — Steam	100	104	114	127	152	169	178	197	210	188	181	190	186	189	188	187	183	187	186	189	195	202	210	209	205	204	203	200	190	189	196	211	212	212	203	206	212	214	234	232	229	231				
Sub-Station Equip	100	103	107	125	152	160	157	189	195	176	172	182	181	181	181	175	171	170	169	170	176	174	184	182	182	184	183	181	173	173	179	185	192	192	184	186	191	192	211	210	209	210				
Plateau Division																																														
Total Construction and Equip	100	103	128	155	183	187	189	211	209	178	179	192	186	191	191	190	188	186	181	185	186	188	198	197	181	183	181	177	171	169	179	188	196	196	195	196	196	206	225	221	216	218				
Electric Plant — Steam	100	101	114	125	153	171	176	192	202	186	178	191	189	191	194	197	196	194	190	193	193	200	208	207	190	198	197	194	188	188	197	211	212	211	210	210	210	212	234	232	229	231				
Sub-Station Equip	100	100	106	124	154	162	154	184	187	173	168	184	183	184	188	185	177	176	172	173	173	171	182	179	175	177	177	175	171	171	177	183	191	191	191	189	189	188	210	209	208	209				
Pacific Division																																														
Total Construction and Equip	100	103	127	156	178	182	194	214	214	185	178	187	182	185	182	180	178	181	175	180	179	182	192	191	176	178	175	172	163	161	170	178	189	188	192	196	197	204	221	218	214	216				
Electric Plant — Steam	100	101	111	127	145	161	179	192	206	191	172	180	178	180	178	178	177	182	178	181	180	187	196	193	185	188	185	182	170	170	178	191	198	197	203	204	204	206	226	223	221	222				
Sub-Station Equipment	100	100	104	125	146	153	160	194	193	180	163	174	173	174	173	167	161	165	162	163	163	161	171	168	165	167	166	164	155	155	161	166	179	179	184	185	185	186	204	203	202	203				

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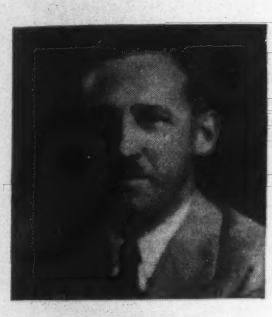

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Relative Value of Utility Systems

C. F. Lambert, Utility Engineer and Consultant, Miami, Fla.

THIS RECORD brings up to Jan. 1, 1939, values of five utilities originally published in *Engineering News-Record*, May 7, 1925 and brought up to date annually in *Construction Costs*, 1931 to 1937.

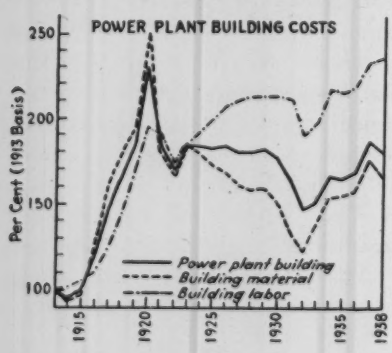
In computing each of these five utility value trends, additional plants have been added until about twice as many are now used as originally. The trend in equipment as well as in prices is thus followed. Values for each year are the average for the entire year.

Definition of the items used in computing these price trends is shown for each utility in the accompanying summary.

Table II shows values on a 1926 base, Table III on a 1913 base. Charts on the opposite page illustrate comparable annual values of all five utilities as well as the annual average trend, the preceding 5- and the preceding 10-year average trends, while Table I gives the 1938 monthly values which also are charted in an adjacent column to demonstrate the definite drop that occurred in the last half of the year. Power plant building values with labor and materials trends are charted separately on this page.

Summary of Data Covered

POWER PLANT BUILDINGS: 50 buildings—Relative values shown by chart only, labor and material trends shown separately. *Building* items include cement in both plain and reinforced concrete, sand, crushed rock,



brick, reinforcing steel, structural steel, roofing, sheet metal, windows, doors, heating material, electric lighting, common labor, carpenters, bricklayers, structural iron workers, metal workers, roofers and electricians.

WATERWORKS: 25 systems 68 items including *Land*, entirely a local matter (study indicates that the most accurate relation of land to other values is obtained by keeping land unit the same throughout the period); *Buildings; Equipment*, boilers, stokers, boiler settings, pumps, motors, steam pumps, condensers, steam piping, miscellaneous equipment, erection; *Distribution*, cast iron pipe, steel pipe, wood pipe, valves, hydrants, meters, standpipes, reservoirs, filter plants, labor; *Miscellaneous*, furniture, fixtures, tools, automobiles, miscellaneous.

ELECTRIC LIGHT PLANTS: 25 plants—84 items including *Land; Buildings; Equipment*, boilers, stokers, steam piping, auxiliary equipment, engines, turbines, diesels, condensers, generators, switchboards; *Distribution*, substation equipment, transformers, lighting equipment, poles, conductors, hardware, wire, insulators, meters, distribution transformers, underground cables, erection; *Miscellaneous*, furniture, fixtures, tools, automobiles, miscellaneous.

STREET RAILWAY SYSTEMS: 10 systems—82 items including *Land; Buildings*, car barns and shops; *Track Construction*, tangent track, special layouts, grading, paving, concrete and steel bridges, rails, spikes, bolts, ties, labor; *Span Construction*, poles, conductors, pole hardware, copper, erection; *Cars & Equipment; Miscellaneous*, furniture, fixtures, tools, automobiles, miscellaneous. Power plant buildings excluded because power is so frequently purchased from separate department or company.

NATURAL GAS PLANTS: 15 systems—58 items including *Land; Buildings; Equipment*, holders, small pumps, miscellaneous; *Distribution*, cast iron pipe, steel pipe, regulators, governors, valves, meters; *Miscellaneous*, furniture, fixtures, tools, autos.

MANUFACTURED GAS SYSTEMS: 25 plants—63 items including *Land; Buildings; Equipment*, boilers, gas machinery holders, miscellaneous; *Distribution*, cast iron pipe, steel pipe, regulators, valves, meters; *Miscellaneous*, furniture, fixtures, tools, autos.

Table I—Relative Monthly Value For 1938 with 1913 = 100

	Water Works	Electric Light	Street Ry.	Natural Gas	Artificial Gas
Jan.	198.0	186.7	169.8	191.2	199.9
Feb.	197.7	183.5	168.3	190.8	199.6
March	197.0	182.9	167.2	190.3	199.1
April	196.9	182.7	166.3	190.0	199.0
May	196.4	181.4	165.0	189.8	198.6
June	194.4	180.0	164.1	189.4	197.9
July	187.1	178.2	163.3	180.5	191.4
August	187.1	178.6	163.3	180.5	191.4
Sept.	186.6	178.5	162.8	179.8	191.0
Oct.	187.5	179.6	161.9	179.9	191.2
Nov.	187.9	180.3	161.9	180.5	191.6
Dec.	188.6	180.8	162.3	181.6	192.2
Average	192.6	181.2	164.6	185.3	195.4

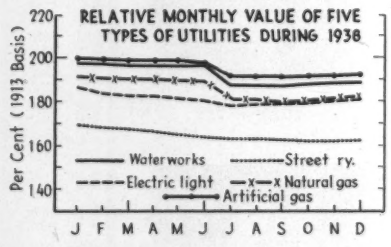


Table II—Relative Yearly Utility Values Based on 1926 Costs—Lambert

	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
Water Works Plants															
A..	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
B..	11.0	10.9	11.0	10.7	10.6	10.8	10.5	9.6	8.8	9.0	9.9	9.9	10.1	11.3	10.9
C..	12.2	12.1	12.0	11.9	12.2	12.3	11.8	11.1	10.3	11.1	12.1	12.0	12.1	13.6	13.1
D..	80.6	75.8	74.4	67.5	65.6	69.8	68.9	65.2	59.7	62.3	68.7	69.4	69.9	76.9	75.6
E..	1.1	1.1	1.1	1.0	1.0	1.0	1.0	.8	.7	.9	.9	.9	.9	1.0	1.0
T..	106.4	101.4	100.0	92.6	90.9	95.4	93.7	88.2	81.0	84.8	93.1	93.7	94.5	104.3	102.1
Electric Light Plants															
A..	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
B..	10.8	10.8	10.8	10.6	10.6	10.8	10.3	9.6	8.7	8.8	9.8	9.8	10.0	11.1	10.7
C..	42.8	42.9	42.5	41.9	42.5	43.9	41.4	38.8	35.5	38.5	43.4	43.1	43.3	48.0	46.9
D..	40.5	41.3	41.6	41.4	42.5	44.2	42.0	39.2	34.5	36.0	41.1	40.6	41.3	46.5	43.8
E..	3.6	3.6	3.5	3.3	3.3	3.3	3.2	2.9	2.6	2.7	2.9	2.9	2.9	3.2	3.1
T..	99.3	100.2	100.0	98.8	100.5	103.8	98.5	92.1	82.9	87.6	98.8	98.0	99.1	110.4	106.1
Street Railway Systems															
A..	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
B..	5.0	5.0	5.0	4.9	4.9	4.9	4.8	4.4	3.9	4.1	4.5	4.5	4.6	5.1	5.0
F..	65.1	63.6	63.6	62.7	62.6	61.7	60.4	57.9	53.5	54.2	56.5	55.5	56.0	60.9	59.0
G..	24.8	23.5	23.5	23.5	23.0	23.0	23.1	19.6	18.6	17.8	20.7	21.0	21.6	24.0	23.4
H..	5.1	4.7	4.6	4.7	4.8	5.0	4.8	4.5	4.0	4.0	4.3	4.3	4.5	4.7	4.5
E..	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.5	1.4	1.4	1.6	1.6	1.6	1.8	1.7
T..	103.3	100.1	100.0	99.1	98.5	97.8	96.3	89.4	82.9	83.0	89.1	88.4	89.8	98.0	95.1
Natural Gas Plants															
A..	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9
B..	1.5	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.3	1.3	1.4	1.4	1.4	1.6	1.6
C..	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.4	1.3	1.4	1.5	1.6	1.7	1.8	1.8
D..	92.3	93.3	93.0	90.6	90.8	91.2	89.9	87.5	82.7	83.2	90.0	89.4	86.1	92.8	91.3
E..	3.0	2.9	2.9	2.8	2.8	2.8	2.8	2.6	2.3	2.3	2.4	2.4	2.4	2.6	2.6
T..	99.4	100.3	100.0	97.4	97.6	97.9	96.6	93.8	88.5	89.1	96.2	95.7	92.5	99.7	98.2
Artificial Gas Systems															
A..	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
B..	6.7	6.6	6.7	6.5	6.4	6.6	6.4	5.9	5.4	5.5	6.1	6.1	6.2	6.9	6.6
C..	32.6	32.2	32.3	32.1	31.6	31.2	28.7	26.2	25.2	27.4	30.6	31.3	31.8	37.1	37.3
D..	57.8	57.1	56.8	54.0	53.8	55.3	54.6	53.2	49.3	49.5	54.3	54.3	53.4	57.3	56.4
E..	2.1	2.1	2.0	2.0	2.0	2.0	1.9	1.8	1.6	1.6	1.7	1.7	1.7	1.8	1.8
T..	101.4	100.2	100.0	96.8	96.0	97.3	93.8	89.3	83.7	86.1	94.9	95.6	95.3	105.3	104.3

A—Land. B—Buildings. C—Equipment. D—Distribution. E—Miscellaneous. F—Track Construction. G—Cars and Equipment. H—Span Construction. T—Total.

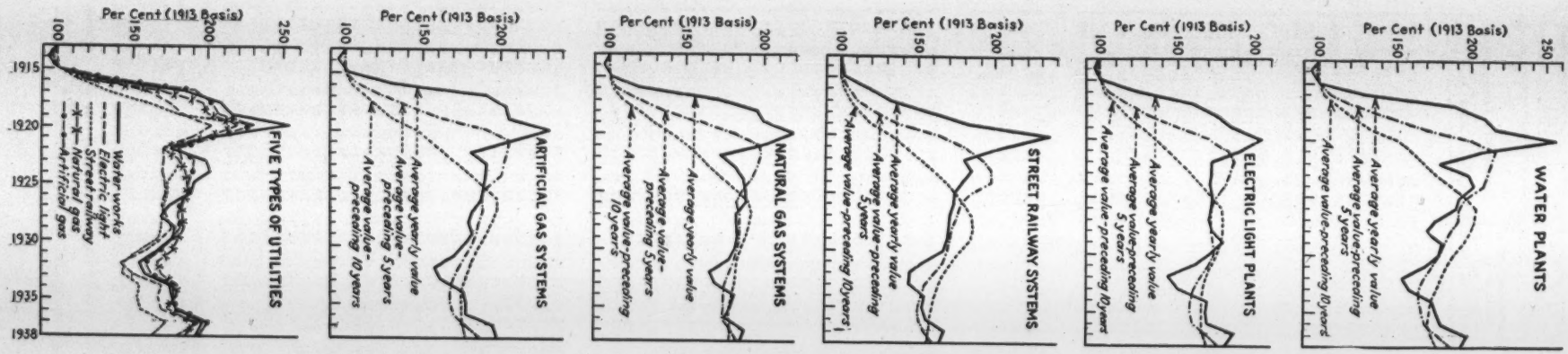


Table III—Relative Yearly Value of Main Items Entering Into Physical Value of Five Utilities 1913-1938—1913=100—Lambert

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
Waterworks Plants																										
Land....	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Bldgs....	11.2	10.8	11.1	13.5	16.5	18.5	20.6	25.6	20.9	19.0	20.8	20.7	20.6	20.7	20.2	20.1	20.4	19.7	18.2	16.6	16.9	18.7	18.6	18.9	20.9	20.5
Equip....	12.1	12.0	14.0	17.3	22.6	23.4	24.3	26.0	23.4	21.8	22.9	23.0	22.9	22.7	22.5	23.0	23.2	22.3	20.9	19.5	21.0	22.9	22.5	22.7	25.0	24.7
Distr.....	72.7	67.1	71.3	94.1	143.2	161.1	165.8	197.8	155.8	130.1	149.8	152.2	143.2	140.5	127.5	123.8	131.8	130.0	123.3	112.6	116.8	129.7	130.7	131.8	144.8	142.7
Misc.....	1.1	1.1	1.2	1.4	1.8	2.0	2.3	2.8	2.2	2.0	2.2	2.0	2.1	2.0	1.9	1.9	1.9	1.9	1.6	1.4	1.6	1.7	1.7	1.7	1.9	1.8
Total..	100.0	93.9	100.5	129.0	187.0	207.9	215.9	255.1	205.2	175.8	198.6	200.8	191.7	188.8	175.0	171.7	180.2	176.8	166.9	153.0	159.2	175.9	176.4	178.0	195.5	192.6
Electric Light Plants																										
Land....	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Bldgs....	10.1	9.7	10.0	12.0	14.9	16.7	18.5	23.1	19.9	17.1	18.8	18.6	18.5	18.6	18.2	18.2	18.5	17.8	16.5	14.9	15.2	16.8	16.7	17.0	18.8	18.4
Equip....	38.9	36.7	36.7	47.9	73.5	79.5	81.0	86.7	84.6	75.1	73.4	73.5	73.6	73.0	72.0	72.9	75.4	71.0	66.6	60.9	66.2	75.5	73.9	74.3	82.2	80.2
Distr.....	44.8	43.5	47.1	56.1	63.4	69.6	75.2	82.6	77.4	70.4	70.4	69.6	70.9	71.2	71.1	72.9	75.8	71.7	67.1	59.4	61.8	70.3	69.2	70.3	79.3	74.6
Misc.....	3.4	3.4	3.4	4.1	5.1	6.0	6.8	8.6	6.8	6.2	6.2	6.1	6.1	6.0	5.7	5.6	5.6	5.5	5.0	4.5	4.6	4.9	4.9	4.9	5.3	5.2
Total..	100.0	96.1	100.0	122.9	159.7	174.6	184.3	203.8	191.5	171.6	171.6	170.6	171.9	171.6	169.8	172.4	178.1	168.8	158.0	142.5	150.6	169.3	167.5	169.3	188.4	181.2
Street Railway Systems																										
Land....	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Bldgs....	4.7	4.5	4.6	5.6	6.9	7.8	8.6	10.8	8.8	8.0	8.8	8.7	8.6	8.6	8.5	8.5	8.6	8.3	7.6	6.9	7.1	7.8	7.8	7.9	8.8	8.5
Trk. Cstr.	64.3	63.1	63.4	71.9	83.3	104.8	113.8	144.1	119.9	105.4	113.6	112.8	110.2	110.2	108.6	108.5	106.9	104.7	100.1	92.9	94.1	97.9	96.0	96.9	104.6	102.2
Span. Cstr	5.8	5.4	6.3	8.7	9.9	9.7	10.0	11.1	9.0	8.5	8.7	8.8	8.1	8.0	8.1	8.4	8.7	8.4	7.8	7.0	7.0	7.5	7.4	7.7	8.2	7.8
Cars. eq..	20.9	22.4	22.8	25.1	27.2	31.1	44.4	61.1	59.1	53.0	47.0	42.9	40.7	40.7	40.7	39.9	39.9	39.9	34.0	32.4	30.8	35.8	36.4	37.3	41.6	40.5
Misc.....	1.7	1.6	1.6	2.2	2.9	3.2	3.5	4.3	3.6	3.2	3.3	3.2	3.2	3.2	3.1	3.0	3.0	3.0	2.7	2.5	2.5	2.7	2.7	2.7	3.0	3.0
Total..	100.0	99.6	101.3	116.1	132.8	159.2	182.9	234.0	203.0	180.7	184.0	179.0	173.4	173.3	171.6	170.9	169.7	166.9	154.8	144.3	144.1	154.3	152.9	155.1	168.8	164.6
Natural Gas Plants																										
Land....	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Bldgs....	1.6	1.5	1.6	1.9	2.4	2.6	2.9	3.7	3.0	2.7	2.9	2.9	3.0	3.0	2.9	2.9	2.9	2.8	2.6	2.4	2.4	2.7	2.7	2.7	3.0	3.0
Equip....	1.7	1.6	1.8	2.6	4.0	3.6	3.5	4.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	2.9	2.8	2.6	2.4	2.7	2.9	2.9	3.0	3.3	3.3
Distr....	92.2	89.9	92.0	111.0	155.7	182.9	186.5	202.4	187.3	158.4	168.7	173.2	175.0	174.6	169.9	170.3	171.1	168.8	164.7	155.0	157.8	169.0	168.2	163.0	175.5	172.6
Misc.....	2.9	2.8	2.9	3.3	4.4	5.1	5.8	7.8	6.4	5.6	5.9	5.7	5.5	5.4	5.3	5.2	5.2	5.2	4.8	4.3	4.2	4.5	4.4	4.4	4.9	4.8
Total..	100.0	97.4	99.9	120.4	168.1	195.8	200.3	219.6	201.4	171.4	182.2	186.5	188.1	187.6	182.7	183.0	183.7	181.2	176.3	165.7	168.7	180.7	179.8	174.7	188.3	185.3
Artificial Gas Systems																										
Land....	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Bldgs....	6.8	6.5	6.7	8.1	10.0	11.2	12.5	15.5	12.7	11.5	12.6	12.5	12.4	12.5	12.2	12.1	12.4	12.0	11.1	10.1	10.3	11.3	11.3	11.5	12.7	12.4
Equip....	30.4	29.1	33.1	49.9	76.4	68.7	67.2	75.9	66.1	62.8	63.4	61.2	60.5	60.6	60.3	59.4	58.7	53.9	49.2	47.2	51.4	57.4	58.3	59.2	68.7	69.1
Distr.....	56.5	54.4	55.6	68.1	98.3	114.8	116.5	130.4	115.6	98.2	107.5	108.6	107.3	106.7	101.5	101.0	103.8	102.6	99.7	92.5	93.8	102.1	102.0	100.3	108.0	106.2
Misc.....	2.1	2.1	2.1	2.5	3.1	3.6	4.1	5.5	4.6	4.1	4.2	4.0	3.9	3.8	3.8	3.7	3.7	3.7	3.5	3.0	3.1	3.2	3.2	3.2	3.5	3.5
Total..	100.0	96.3	101.7	132.8	192.0	202.5	204.5	231.5	203.2	180.8	191.9	190.5	188.3	187.8	182.0	180.4	182.8	176.4	167.7	157.0	162.8	178.2	179.0	178.4	197.1	195.4

Boeckh Index of Construction Costs — U. S. Average, 1926–'29 = 100

Annual Averages By Cities	Residences		Apartments, Hotels, Office Bldgs.			Commercial & Factory Bldgs.				
			Brick and					Brick and		
	Frame	Brick	Wood	Conc.	Steel	Frame	Steel	Wood	Steel	Conc.
ATLANTA AREA										
1926–29	82.7	87.0	84.2	83.7	87.0	82.9	94.5	84.7	87.5	86.8
1933	41.2	43.7	42.4	43.3	45.6	40.6	45.2	43.0	44.3	43.0
1934	39.5	42.2	40.8	42.2	43.9	38.7	44.1	41.4	43.4	42.1
1935	41.0	43.6	42.0	43.3	44.7	40.1	44.3	42.8	43.7	43.8
1936	46.0	48.9	48.9	52.6	55.5	44.8	66.9	48.4	57.6	53.8
1937	54.4	57.2	56.6	63.7	69.4	46.0	90.6	56.6	74.4	63.9
1938	71.3	74.8	72.7	74.6	80.1	69.7	93.2	72.4	80.7	75.4
1939	103.6	105.1	100.6	87.0	95.0	105.5	95.3	96.1	90.9	86.5
1920	137.1	139.6	133.1	110.6	119.6	140.6	111.8	129.6	108.5	111.0
1921	85.1	88.1	83.9	81.9	84.0	84.5	75.6	82.2	76.8	84.0
1922	83.4	85.8	81.8	79.6	82.2	83.6	73.1	79.5	74.6	80.6
1923	88.6	92.8	89.1	88.9	91.5	88.3	86.7	88.0	86.1	91.9
1924	85.0	89.8	89.2	91.1	91.9	88.8	88.8	88.3	89.8	94.7
1925	81.7	86.5	85.6	88.6	88.6	85.3	89.4	85.1	83.4	92.5
1926	83.1	87.1	83.7	85.1	86.4	82.1	93.4	84.5	86.6	85.1
1927	82.4	85.9	83.6	83.2	84.6	81.8	96.5	84.2	85.5	85.6
1928	85.6	89.4	86.7	86.0	87.9	84.8	93.3	85.7	88.5	86.6
1929	79.7	85.6	82.8	80.5	88.2	82.9	94.8	84.4	89.4	89.9
1930	80.9	85.3	82.8	84.5	85.7	78.2	91.8	83.6	83.6	86.1
1931	78.6	82.8	80.2	80.4	80.4	77.2	82.2	81.6	80.4	82.1
1932	71.0	75.2	73.6	77.2	77.0	68.7	80.8	77.4	78.1	78.3
1933	64.6	69.6	68.3	77.9	76.1	62.7	79.5	71.8	79.0	82.0
1934	70.6	76.6	74.6	83.8	83.4	68.9	91.5	78.5	86.4	87.4
1935	68.4	72.4	73.2	83.9	82.6	64.9	89.7	77.7	85.6	87.6
1936	68.4	72.4	73.2	84.4	83.3	65.8	89.7	77.8	85.8	87.1
1937	79.0	85.1	82.8	92.7	92.2	76.7	97.9	85.7	93.7	95.2
1938	81.6	85.0	85.2	95.9	96.2	79.5	100.5	87.4	96.9	98.1
BALTIMORE AREA										
1926–29	107.2	112.0	107.6	100.6	100.7	106.3	95.5	106.8	96.8	101.2
1934	83.8	89.1	86.2	89.9	88.5	81.5	86.9	89.1	88.5	91.0
1935	80.0	85.5	82.7	89.9	87.3	78.1	87.6	85.5	88.1	90.6
1936	80.9	85.8	82.4	89.4	88.0	80.0	88.4	86.5	88.3	90.3
1937	88.8	93.2	90.4	93.4	93.8	87.9	97.0	91.8	95.4	93.0
1938	91.9	94.8	94.1	98.0	98.0	91.7	100.4	95.6	99.5	98.5
BOSTON AREA										
1926–29	116.3	120.3	115.4	106.2	107.0	118.8	106.3	112.5	108.7	105.8
1934	94.4	101.1	97.1	101.4	98.3	93.2	99.6	97.8	101.6	104.1
1935	91.2	97.6	94.5	98.2	95.3	90.8	98.5	95.0	100.4	101.1
1936	87.9	94.2	90.8	96.3	93.9	87.3	98.5	92.9	98.6	98.1
1937	103.3	110.5	106.6	111.6	109.2	103.5	112.1	107.6	114.4	113.2
1938	104.1	109.4	107.8	114.5	111.9	103.8	113.9	109.1	117.0	116.4
CHICAGO AREA										
1926–29	109.2	114.2	109.8	113.2	109.1	112.9	105.2	105.9	112.9	116.0
1934	93.4	99.2	94.6	105.0	99.9	95.2	102.8	93.9	103.4	109.9
1935	91.5	97.9	92.4	103.8	98.2	93.0	99.8	92.4	102.4	109.4
1936	97.2	102.9	97.8	110.0	103.9	100.4	105.0	96.6	109.7	115.9
1937	104.8	110.7	105.9	116.9	111.8	108.3	109.1	104.0	115.3	120.8
1938	107.9	110.6	109.5	122.7	117.8	111.5	117.9	108.0	122.4	126.7
CINCINNATI AREA										
1926–29	100.5	105.0	101.3	101.0	100.2	100.2	99.6	103.1	100.6	101.0
1934	93.4	99.2	94.6	105.0	99.9	95.2	102.8	93.9	103.4	109.9
1935	86.4	92.3	89.1	93.5	91.5	83.7	92.9	92.8	94.9	94.5
1936	84.5	89.9	87.7	93.2	90.8	81.9	92.6	91.8	92.6	93.3
1937	98.8	106.1	102.9	107.5	105.3	98.2	107.9	104.7	109.1	109.7
1938	100.4	105.1	104.0	112.4	109.2	100.0	111.7	106.0	113.4	114.8
CLEVELAND AREA										
1926–29	107.2	113.4	108.5	111.3	108.3	109.0	103.0	107.2	110.5	114.8
1934	89.6	97.0	93.4	98.0	95.0	89.0	94.1	95.9	98.7	101.6
1935	87.6	94.5	90.9	96.7	93.5	87.5	94.9	91.7	98.2	100.3
1936	91.7	98.8	94.7	100.0	95.1	92.3	98.1	94.0	101.2	100.3
1937	105.1	112.3	107.7	112.5	109.1	106.5	110.6	108.1	114.8	116.3
1938	105.8	109.8	109.4	115.5	112.8	107.0	113.0	109.9	118.1	118.3
DALLAS AREA										
1926–29	112.8	115.8	111.0	102.2	103.4	114.7	104.6	106.7	103.1	102.4
1934	86.2	91.6	89.3	88.1	89.3	83.7	95.7	91.5	92.4	87.5
1935	82.8	88.9	86.3	85.1	85.1	79.5	84.8	90.8	81.5	84.9
1936	82.5	87.1	84.1	84.5	84.8	81.4	88.0	85.8	86.9	85.1
1937	89.9	95.2	92.2	92.0	94.2	88.5	95.0	94.4	94.1	92.3
1938	91.2	92.6	92.7	95.5	96.6	89.7	102.5	93.6	98.1	94.8
DETROIT AREA										
1926–29	103.3	108.4	104.3	102.9	102.4	103.7	103.1	103.5	103.5	104.4
1934	82.5	86.6	83.5	87.8	87.4	82.2	90.7	83.9	89.2	88.3
1935	78.1	83.4	81.0	88.1	87.1	77.5	92.6	81.8	90.5	90.2
1936	80.6	85.9	84.1	91.9	90.2	80.5	95.9	84.2	95.2	95.3
1937	93.9	100.7	97.3	103.4	101.7	94.3	107.0	97.6	107.4	106.5
1938	97.1	101.8	101.8	108.7	107.3	96.9	110.3	102.9	112.5	110.5
MINNEAPOLIS AREA										
1926–29	92.8	98.2	94.6	95.6	96.1	92.8	100.0	93.9	97.9	98.4
1934	87.0	94.0	90.9	86.8	87.4	84.2	89.5	94.8	89.1	90.5
1935	82.7	88.6	85.7	85.9	86.6	80.2	90.2	88.9	87.7	89.5
1936	88.6	93.6	89.2	92.6	91.6	88.7	96.1	89.2	94.3	95.7
1937	101.6	107.6	104.2	108.6	106.8	103.0	111.7	101.8	111.6	112.1
1938	101.2	105.5	103.9	113.4	111.2	102.1	114.7	103.3	115.2	117.2
NEW ORLEANS AREA										
1926–29	93.3	96.3	93.4	86.5	90.6	93.3	93.7	91.5	89.5	86.5
1934	76.5	81.5	79.3	81.9	83.5	74.0	88.8	79.6	84.2	82.6
1935	76.2	81.3	89.2	81.8	83.4	73.6	88.7	79.7	84.2	82.5
1936	73.4	78.8	76.6	81.8	83.2	70.4	88.9	77.6	83.7	82.6
1937	83.4	87.0	84.7	86.6	89.9	82.6	98.1	84.4	91.6	85.6
1938	86.3	87.5	88.5	92.2	95.6	85.0	102.0	88.3	96.0	91.5
PHILADELPHIA AREA										
1926–29	100.3	107.6	103.7	105.9	103.1	98.1	96.3	106.2	102.2	108.8
1934	84.8	91.0	87.6	91.2	88.7	82.4	81.9	91.6	87.6	92.5
1935	85.4	91.9	88.6	91.3	89.3	82.7	83.4	92.1	88.9	94.7
1936	88.7	95.5	93.0	96.5	92.6	85.7	91.7	97.2	94.7	98.9
1937	91.4	98.0	95.3	98.7	97.8	89.1	100.9	97.7	99.7	100.3
1938	93.8	98.5	98.6	104.6	102.2	92.4	103.7	101.7	104.7	106.7

Annual Averages By Cities	Residences		Apartments, Hotels, Office Bldgs.			Commercial & Factory Bldgs.				
			Brick and					Brick and		
	Frame	Brick	Wood	Conc.	Steel	Frame	Steel	Wood	Steel	Conc.
NEW YORK CITY AREA										
1926–29	133.3	138.4	131.9	122.8	120.4	137.5	113.1	127.4	123.2	125.3
1913	59.5	60.6	57.5	53.9	54.8	61.4	51.4	53.2	53.2	53.7
1914	59.1	60.2	56.9	53.3	53.8	61.3	51.2	53.9	53.1	54.6
1915	57.6	58.7	55.7	52.5	52.8	60.3	49.0	53.1	51.8	53.1
1916	65.9	67.5	65.1	62.3	65.2	67.8	75.6	62.3	69.0	62.1
1917	77.6	78.9	76.4	73.2	78.7	79.9	97.0	72.5	83.9	72.3
1918	87.7	89.9	86.4	82.2	87.2	89.2	98.2	83.6	89.2	83.1
1919	100.5	103.5	99.3	92.0	96.9	101.2	97.1	97.2	93 6	91.6
1920	136.9	142.0	135.8	123.3	130.0	137.1	120.9	135.0	122.6	123.6
1921	109.8	114.5	109.2	101.3	100.8	110.0	96.1	109.1	100.1	103.5
1922	109.5	114.3	109.0	99.0	98.7	109.8	88.4	109.3	96.3	100.1
1923	124.6	131.3	125.6	112.3	112.2	125.5	105.7	127.0	112.7	115.8
1924	123.5	129.1	123.6	114.4	113.9	125.0	108.5	122.4	115 6	115.7
1925	122.8	126.9	120.4	111.4	110.1	125.7	104.2	117.5	110 3	113.3
1926	131.4	136.9	130.1	120.3	116.7	133.7	118.3	128.1	118.2	123.0
1927	128.4	133.3	126.4	117.2	113.1	131.4	106.5	123.6	115.6	119.9
1928	136.5	140.2	133.5	125.8	122.6	140.5	112.4	126.6	128.2	128.0
1929	140.6	143.2	137.6	127.9	129.2	144.4	115.2	131.3	130 8	130.3
1930	126.7	132.6	125.3	124.1	118.7	131.9	113.8	120.3	123 6	128.0
1931	117.8	124.0	117 8	119.7	113.9	122.7	116.7	113.4	122.8	123.8
1932	100.4	108.1	102.6	105 5	99.8	104.8	102.2	99.8	109 1	112.0
1933	85.0	92.4	88.4	101.1	93.3	85.2	90.1	91.0	97.6	106.2
1934	98.3	104.5	100.2	108.2	103.5	99.8	104.6	100.2	108.8	112.2
1935	92.2	92.5	93.2	103.6	99.6	94.1	102.9	92.9	105.3	107.4
1936	96 4	101 8	97 4	106 8	102.2	98 8	104 9	96 2	107 2	110.5
1937	110.5	115.8	111.2	119.6	116.5	113.1	117.8	109.1	120.6	121.2
1938	118.9	121.4	119.6	128.4	124.0	121.9	123.2	117.0	128.3	130.4
PITTSBURGH AREA										
1926–29	113.3	118.8	112.8	111.2	107.1	115.4	89.6	112.2	104.6	112.9
1934	83.7	91.1	87.7	86.9	85.1	80.6	73.4	93.3	82.9	88.4
1935	84.1	90.5	86.1	94.9	83.9	82.2	72.3	89.5	80.9	86.6
1936	92 8	100.4	95.8	97.9	93.8	92.4	82.6	98.4	93.4	101.8
1937	109.8	117.5	112.9	112.1	109.0	109.1	102.1	115.3	110.6	114.1
1938	112.7	116.4	114.7	117.1	113.7	113.2	114.2	115.6	116.6	118.9
ST. LOUIS AREA										
1926–29	118.6	121.1	115.7	109.9	108.8	121.3	103.3	111.7	107.7	109.3
1913	62.6	63.7	60.0	56.7	57.3	63.9	53.4	57.8	54.7	57.6
1914	61.1	62.2	59.1	54.4	54.8	62.6	51.4	56.7	53.4	54.7
1915	62.1	63.7	60.3	56.9	56.3	63.6	52.6	57.9	55.1	58.6
1916	58.8	61.3	59.7	62.6	64.9	59.5	79.9	58.1	70.1	62.8
1917	69.7	71.4	69.5	71.7	79.5	71.1	95.3	66.5	81.3	71.5
1918	88.4	89.8	86.3	82.5	87.9	90.6	99.2	81.4	89.1	82.7
1919	95.0	97.5	93.6	91.4	96.4	96.7	99.1	90.1	93.8	91.6
1920	121.0	123.3	118.5	112.1	120.0	123.4	116.1	113.7	113.1	110.7
1921	113.3	116.5	110.5	105.0	104.1	115.3	99.4	107.4	103 2	106.7
1922	98.1	102.4	97.9	96.2	95.7	98.7	89.6	96 8	93.9	97.4
1923	116.5	120.9	115.4	110.2	110.2	119.0	104.9	112 6	109.4	111.7
1924	122.1	126.9	120.7	117.3	114.6	125 0	109.1	117.8	115.7	119.2
1925	118.4	123.6	117.9	116.3	113.2	120.9	107.0	115.6	114.4	118.1
1926	120.7	125.4	119.6	115.5	112.8	123.8	106.5	116.5	114.3	116.9
1927	118.1	122.7	116.7	113.5	110.1	121.2	105.4	113.5	112.5	116.0
1928	117.9	119.2	114.2	106.6	97.5	121.1	102.7	110.6	103.6	106.6
1929	117.7	118.1	112.3	104.0	97.2	119.0	98.6	106.2	100.4	103.8
1930	108.3	113.2	108.4	112.4	107.9	110.6	106.2	106.0	111 3	115.3
1931	103.3	108.4	104.0	108.0	102.9	105.6	102.8	102.1	107.8	110.5
1932	95.0	100.7	96.5	99.0	94.6	97.1	97.0	95.0	101.2	102.4
1933	87.3	94.0	90.1	97.9	93.2	88.4	96.8	90.2	99.6	102.8
1934	97.6	105.5	101.7	105.9	102.3	97.2	102.6	103.7	107.6	109.7
1935	91.6	99.7	96.4	104.2	99.3	90.7	101.8	98.9	105.7	108.6
1936	91.0	99.1	95.5	104.9	100.7	90.5	103 3	98.1	106.2	106.3
1937	98.2	106.5	103.2	113.1	111.1	97.8	114.8	106.0	117.0	117.6
1938	104.1	108.5	107.5	118.5	116.4	103.7	117.1	108.5	120.5	122.4
SAN FRANCISCO AREA										
1926–29	87.7	93.7	90.4	97.5	96.5	86.1	95.5	91.8	95.9	99.0
1913	51.7	56.8	55.0	63.8	61.4	49.7	68.8	57.1	64.4	67.8
1914	50.7	55.8	53.6	61.6	58.0	48.7	60.3	55.8	59.4	66.0
1915	51.1	56.3	53.9	62.5	58.5	49.0	60.7	56.2	59.8	67.5
1916	54.1	59.3	58.3	67.6	67.7	52.2	86.2	60.2	73.9	70.1
1917	63.0	67.7	67.8	77.2	81.9	61.7	118.7	68.0	94.6	78.1
1918	76.6	81.0	79.1	85.8	89.1	75.5	109.2	78.7	94.3	87.4
1919	87.8	92.7	90.1	96.7	100.1	87.2	112.1	89.7	102.2	98.5
1920	107.7	112.8	109.8	115.2	121.1	106.9	133.0	109.6	122.1	115.1
1921	89.5	96.8	93.8	102.3	100.2	86.3	106.5	97.2	103.8	105.6
1922	88.3	94.7	91.1	97.1	95.2	86.9	94.9	92.9	95.6	100.5
1923	98.7	104.8	100.8	103.1	103.0	98.8	103.5	100.8	103.1	106.4
1924	86.7	94.2	91.2	99.9	98.0	84.6	99.7	94.3	99.7	103.8
1925	86.5	93.9	91.1	99.5	97.9	84.1	97.0	93.4	98.0	102.1
1926	88.6	96.5	92.2	103.3	100.3	87.3	100.0	95.2	102.6	107.0
1927	87.2	94.8	91.2	102.1	98.3	86.1	97.2	93.1	100.5	103.3
1928	88.1	93.2	90.1	93.1	94.9	86.0	93.5	90.8	90.5	94.4
1929	86.9	90.3	88.1	91.9	92.5	85.0	91.3	88.1	90.0	92.3
1930	86.8	93.8	90.3	100.4	96.8	86.2	100.0	92.0	100.4	104.9
1931	80.6	88.8	85.6	94.6	90.6	79.2	92.5	87.3	94.8	100.7
1932	76.4	84.3	81.6	87.9	84.0	75.4	88.0	84.6	89.8	94.1
1933	68.4	76.7	74.3	84.7	81.0	66.3	82.1	78.5	85.3	89.5
1934	85.0	93.2	90.5	97.5	94.5	82.9	97.2	94.7	99.3	102.4
1935	84.1	91.6	89.0	96.5	94.9	82.1	99.9	92.9	99.8	103.7
1936	86.5	95.6	92.3	103.5	99.8	84.8	102.6	96.2	104.3	109.7
1937	96.7	104.3	101.9	112.2	109.8	95.4	113.0	104.8	113.3	116.0
1938	97.7	105.3	101.8	115.8	112.3	96.1	115.7	105.9	116.0	120.2
SEATTLE AREA										
1926–29	84.5	92.2	89.2	101.7	95.1	82.4	100.8	92.2	100.5	105.9
1934	78.2	86.5	83.8	95.2	92.1	74.9	97.1	87.9	86.2	100.0
1935	81.1	88.6	85.6	92.8	94.6	78.5	99.0	88.1	98.1	101.2
1936	79.8	86.5	83.6	93 7	92.2	77.3	97.4	85.7	95.2	96.5
1937	92.6	103.5	100.4	116.0	110.0	90.0	117.0	106.8	118.1	122.2
1938	96.5	104.3	103.5	119.8	115.7	94.0	120.2	107.6	120.8	125.6

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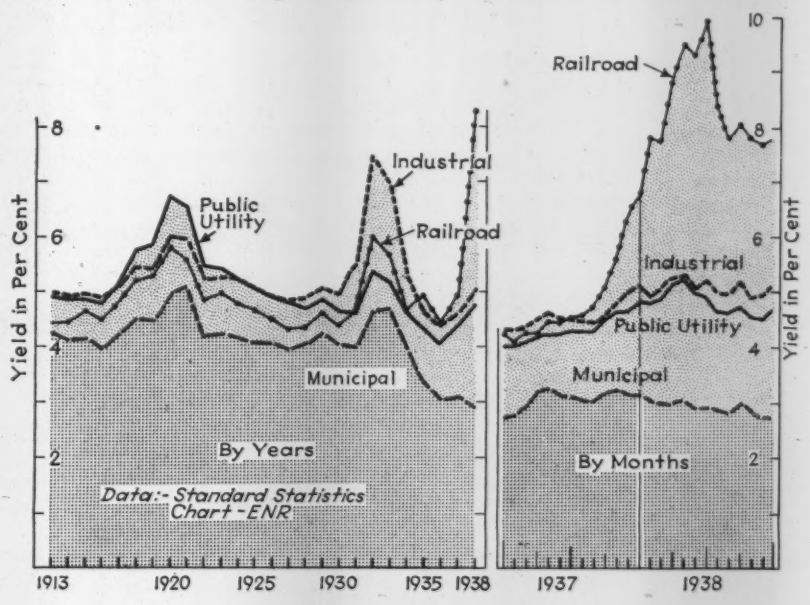
For definition of this index see p. 84

Cost of Financing

Cost of financing as measured by high-grade bond yields disclosed that municipal bonds averaged 2.91 during 1938, the lowest annual average on record. Industrial, utility and railroad bond yields all report increases compared with the 1937 average. Financing costs on all types of bonds were lower in the second half of 1938, and the lower yields continue throughout the first quarter of 1939.

Railroad financing costs reached the all-time high of 9.92 per cent in June, 1938, dropped to 7.76 in December, and thence to 7.41 in March, 1939.

Domestic money rates, that is rates charged customers by banks, were also below those charged in 1937. New York rates ranged from 2.16 to 2.40 per cent; rates in eight northern and western cities, from 3.25 to 3.47; and those in 27 southern and western cities, from 4.04 to 4.16 per cent.



Yields of High-Grade Bonds

BOND YIELDS — PER CENT

	U. S. Treas. (1)	Municipal (2)	Industrial (3)	Pub. Util. (4)	Railroad (5)
1932 Ave.	3.68	4.65	7.46	5.36	5.99
1933 Ave.	3.31	4.71	6.93	5.18	5.65
1934 Ave.	3.12	4.03	5.30	4.62	4.66
1935 Ave.	2.79	3.41	4.61	4.31	4.93
1936 Ave.	2.65	3.07	4.37	4.02	4.42
1937 Ave.	2.68	3.10	4.60	4.35	4.92
1938 Ave.	2.56	2.91	5.07	4.80	8.37
1938 Jan.	2.65	3.03	4.92	4.80	7.79
Feb.	2.64	2.99	5.09	4.86	7.73
Mar.	2.64	2.99	5.23	5.11	8.90
Apr.	2.62	3.03	5.29	5.22	9.47
May	2.51	2.91	5.04	4.99	9.26
June	2.52	2.91	5.22	4.91	9.92
July	2.52	2.87	4.99	4.65	8.34
Aug.	2.51	2.82	4.97	4.61	7.78
Sep.	2.58	3.02	5.13	4.72	8.06
Oct.	2.48	2.82	4.87	4.55	7.75
Nov.	2.50	2.74	4.96	4.52	7.69
Dec.	2.49	2.75	5.14	4.68	7.76
1939 Jan.	2.47	2.70	5.08	4.58	7.61
Feb.	2.44	2.70	4.98	4.52	7.66
Mar.	....	2.67	4.90	4.45	7.41

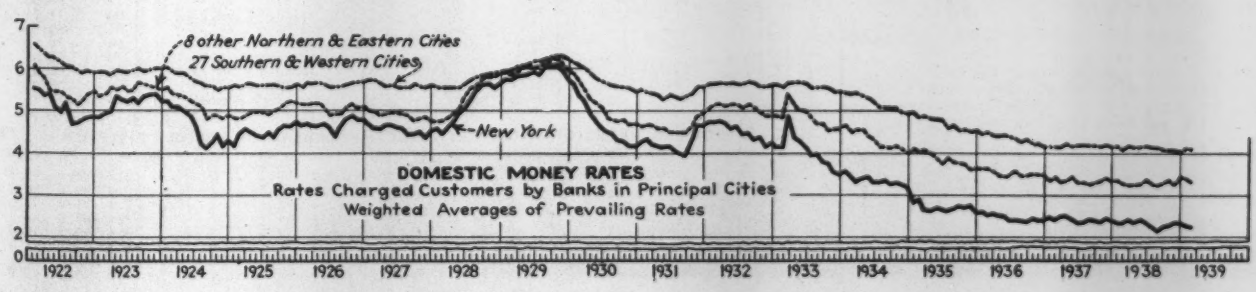
(1) Ave. all U. S. bonds except those due or callable within 12 years.
(2) Standard Statistics Co.— Ave. 15 high-grade long-term municipal issues.
(3) Standard Statistics Co.— Ave. 15 high-grade industrials.
(4) Standard Statistics Co.— Ave. 15 high-grade public utility issues.
(5) Standard Statistics Co.— Ave. 15 high-grade rail issues.

RATE OF INTEREST — MUNICIPAL BOND SALES IN THE U. S. FROM COMMERCIAL & FINANCIAL CHRONICLE

(Millions of Dollars — 000,000 Omitted)

Year	2%	3%	3¼%	3½%	3¾%	4%	4¼%	4½%	4¾%	5%	Over 5¼%	5½%	5¾%	6% & over	Not Known
1901	...	11	...	**69**	...	28	...	5	...	9	3	...	...	...	7
1902	...	12	...	77	...	34	...	4	...	10	2	...	...	...	8
1903	...	17	...	**55**	...	47	...	9	...	14	5	...	...	...	5
1904	...	13	...	**123**	...	75	...	12	...	20	4	...	...	...	4
1905	...	6	...	**81**	...	55	...	14	...	19	6	...	...	...	3
1906	...	17	...	19	...	**120**	...	15	...	17	7	...	...	...	6
1907	...	9	...	8	...	**98**	...	69	...	26	8	...	...	...	9
1908	...	8	...	10	...	**124**	...	104	...	42	13	...	...	...	11
1909	...	21	...	17	...	**163**	...	49	...	55	25	...	...	...	10
1910	...	15	...	17	...	**95**	...	53	...	45	31	...	...	...	63
1911	...	2	...	7	...	**127**	...	89	...	65	29	...	...	...	78
1912	...	3	...	5	...	**101**	80	87	...	68	32	...	...	...	10
1913	...	19	...	4	...	80	20	**132**	...	108	31	...	...	...	10
1914	...	15	...	...	...	72	77	**153**	...	107	40	...	...	...	11
1915	...	2	...	...	...	85	46	**192**	...	117	44	...	...	...	12
1916	...	2	...	1	...	**125**	80	105	...	92	38	...	...	...	13
1917	...	9	...	1	...	96	16	**150**	...	120	42	...	...	...	18
1918	...	2	...	...	...	19	4	69	...	**98**	74	...	...	...	30
1919	...	4	...	...	...	19	22	132	28	**278**	150	...	...	...	59
1920	...	...	...	15	...	24	3	71	9	194	**333**	...	...	...	34
1921	...	...	...	...	...	53	3	125	36	330	**656**	...	...	...	26
1922	...	1	...	...	...	105	131	219	56	**307**	252	...	...	...	32
1923	...	...	...	...	...	98	102	**272**	138	237	203	...	...	...	13
1924	...	...	4	...	...	150	**339**	291	109	281	203	...	...	...	22
1925	...	...	1	...	...	270	**302**	318	76	202	201	...	...	...	30
1926	...	...	...	...	...	212	287	**342**	76	215	199	...	...	...	35
1927	...	16	10	...	...	**361**	321	336	79	180	160	...	...	...	46
1928	...	...	37	...	...	**365**	384	281	68	150	111	...	...	...	19
1929	...	3	65	...	...	107	133	**449**	132	250	281	...	...	...	10
1930	...	2	60	...	...	338	326	**341**	150	155	97	...	...	...	18
1931	...	92	...	181	...	**241**	311	197	51	99	77	...	...	...	6
1932	...	31	...	19	...	68	56	151	73	122	**322**	...	...	...	7
1933	...	32	15	29	39	**131**	48	51	22	61	3	20	3	52	15
1934	84	107	94	54	72	**197**	54	75	41	88	13	23	4	13	20
1935	161	**349**	62	137	71	234	40	50	22	26	3	3	2	9	50
1936	211	**343**	71	156	35	212	14	23	3	16	1	1	...	2	28
1937	73	**422**	55	95	50	134	26	13	3	7	1	1	...	1	21

Bold face type indicates interest rates on which bulk of financing was done for year.

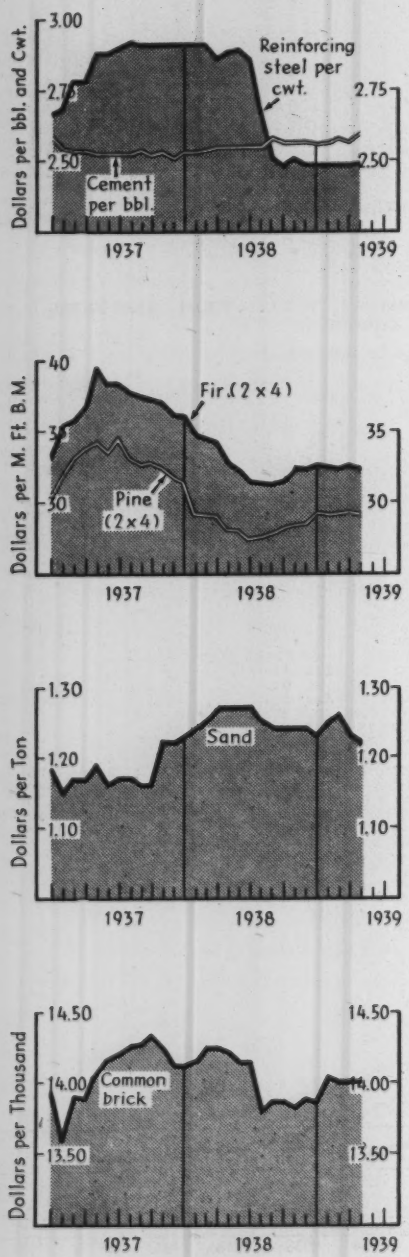


Prices of Construction Materials

BASIC CONSTRUCTION material price averages for 1938 reveal mixed movements compared with the consistent rise in 1937. Pittsburgh base price of structural steel shapes averaged $2.18 for the year, a drop of 3c. from 1937. The mid-year reduction from $2.25 to $2.10 per 100 lb. is responsible. Lumber, 3x12 pine at New York, ranged from $58 to $65 during the year, but the average price of $59.33 is 4 per cent under a year ago as reported by New York Lumber Trade Journal. Cast iron pipe, f.o.b. Delaware River foundries, dropped to $48.33 from $48.75.

New York common brick prices rose from an average of $12.50 in 1937 to $13.10 in 1938. Cement prices in New York likewise increased, rising from an average of $2.07 in 1937 to $2.12 in 1938. Prices during the year, excluding bag cost, varied from $2.05 at the start to $1.95 in July, $2.30 in August, and $2.20 in October.

CONSTRUCTION MATERIAL PRICES
1937 to Date
(*ENR* 20-Cities' Aver.)



Basic Building Materials Prices

1874 to 1937 in New York City

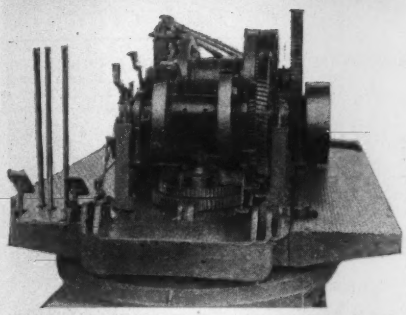
Average yearly prices at New York, except in the case of steel, which is f. o. b. Pittsburgh mill; wrought, iron I beams for years, 1879, 1885 and 1886. Brick, wholesale, f. o. b. Lime, common lump, wholesale, f. o. b., 180 lb., net., 1910–15, incl.; afterward, 280 lb. Cement, net, delivered; *Rosendale, 1874 to 1878-incl.*; afterward, Portland. Lumber, No. 1 com., rough, wholesale, at dock, for 1 in., yel. pine, 1874 to 1909, incl.; afterward, 5 in., long-leaf to 1913, incl. *LLYP–3 x 12—from Lumber Trade Journal. †LLYP–12 x 12 as reported to Engineering News-Record. Cast iron pipe price per ton f. o. b. Delaware River foundries; *prices prior to 1901 are for all classes of bell and spigot;* prices subsequent to 1901 are for 6-in. and larger Cl. B or heavier bell and spigot; early prices from "Price History of Cast Iron Pipe" by United States Cast Iron Pipe and Foundry Co.; prices 1850, $35.72; 1855, $40.18; 1860, $32.15; 1865, $58.05; 1870, $50.

	Brick Common Per M	Cement Per Bbl.	Lime Per Bbl.	Pine per M. Ft. B.m.		Steel Shapes, Per 100 Lb.	Cast Iron Pipe, Per Ton
1874	$7.41	*$1.48*	$1.50	$26.00		....	*$43.76*
1875	7.12	*1.25*	1.40	21.00		....	*37.51*
1876	5.87	*1.20*	1.00	21.00		....	*31.26*
1877	4.93	*1.10*	.80	20.00		....	*25.00*
1878	4.71	*.95*	.70	20.00		....	*23.22*
1879	4.08	2.70	.80	20.96		$2.78	*29.47*
1880	7.00	2.88	.87	19.00		....	*29.47*
1881	7.50	2.72	.95	19.00		....	*33.04*
1882	7.12	2.82	1.01	19.00		....	*35.68*
1883	8.28	2.75	1.05	19.00		....	*32.15*
1884	6.65	2.60	.95	19.00		....	*26.79*
1885	6.10	2.28	1.00	18.66		3.12	*25.00*
1886	7.51	2.28	1.00	19.00		3.00	*26.79*
1887	7.43	2.07	.82	19.00		....	*28.58*
1888	6.50	2.16	.83	16.75		....	*25.00*
1889	7.06	2.23	.92	20.31		....	*23.04*
1890	6.65	2.25	.95	21.75		....	*24.65*
1891	5.53	2.38	.87	18.00		....	*23.04*
1892	5.77	2.27	.93	18.50		....	*21.43*
1893	5.83	2.15	.93	18.50		....	*21.30*
1894	5.00	2.03	.85	18.50		1.20	*18.47*
1895	5.31	1.97	.78	16.92		1.35	*17.95*
1896	5.06	2.00	.69	16.42		1.60	*17.64*
1897	4.94	1.97	.72	16.44		1.24	*15.48*
1898	5.75	2.00	.70	15.75		1.27½	*15.48*
1899	5.69	2.05	.75	16.25		1.45	*21.17*
1900	5.25	2.16	.68	24.50		1.95	*22.33*
1901	5.77	1.89	.77	17.50		1.60	*21.63*
1902	5.39	1.95	.81	21.00		1.60	26.62
1903	5.91	2.03	.79	23.50		1.70	27.56
1904	7.50	1.67½	.80	21.50		1.60	22.92
1905	8.10	1.43	.89	24.92		1.62	26.54
1906	8.55	1.55	.95	29.33		1.60	30.12
1907	6.16	1.55	.95	30.50		1.75	31.52
1908	5.10	1.46	1.05	30.50		1.76	24.69
1909	6.39	1.41	1.05	33.04		1.50	24.19
1910	5.70	1.07	.75	24.00		1.46	22.99
1911	5.31	1.04	.75	24.63		1.36	19.99
1912	6.75	.97	.75	24.92		1.33	21.22
1913	6.75	1.18	.91½	* 25.04	†	1.50	21.96
1914	5.50	1.17½	.97	21.79	29.25	1.16	20.37
1915	5.50	1.00	.97	21.68	27.91	1.28	22.52
1916	8.00	1.32	1.50	27.60	31.58	2.45	30.25
1917	9.10	1.76	2.02	38.00	37.81	3.62	52.33
1918	10.98	2.48	2.16	46.68	43.33	3.00	58.68
1919	15.79	2.63	2.65	57.04	49.60	2.52	53.87
1920	18.00	3.52	3.15	71.17	66.50	2.45	71.77
1921	17.40	2.82	3.47	50.67	51.54	2.00	50.58
1922	16.91	2.43	2.79	49.41	51.83	1.70	46.42
1923	20.00	2.66	2.98	61.77	62.25	2.39	57.75
1924	18.00	2.50	2.88	55.17	59.00	2.19	54.33
1925	15.00	2.50	2.38	57.00	59.67	1.95	49.16
1926	17.00	2.50	2.18	60.33	62.17	1.93	48.50
1927	15.00	2.40	2.49	62.57	61.46	1.86	41.42
1928	14.00	2.30	2.30	63.33	61.34	1.87	35.92
1929	11.71	2.23	2.25	64.50	63.00	1.92	36.66
1930	10.88	2.19	2.25	64.33	60.64	1.71	37.00
1931	10.29	1.89	2.25	58.17	53.02	1.63	34.71
1932	9.75	1.62	2.25	39.91	41.33	1.56	30.58
1933	9.50	2.26	2.50	46.25	46.79	1.64	34.58
1934	10.87	2.48	2.50	57.17	58.92	1.78	41.00
1935	11.00	2.15	2.35	51.67	53.75	1.80	42.58
1936	12.00	2.26	2.80	56.75	57.75	1.84	43.00
1937	12.50	2.07	2.80	61.50	66.46	2.21	48.75
1938	13.10	2.12	2.80	59.33	62.75	2.18	48.33

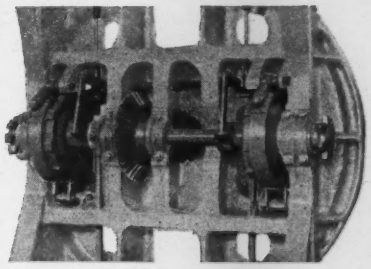
INDEX NUMBERS OF WHOLESALE PRICES—BUREAU OF LABOR STATISTICS

(1926 = 100)	1938	1937	1936	1935	1934	1933	1932	1931	1930	1929
Building materials	90.3	95.2	86.7	85.3	86.2	77.0	71.4	79.2	89.9	95.4
Brick and tile	91.0	93.5	88.7	89.4	90.2	79.2	77.3	83.6	89.8	94.3
Cement	95.5	95.5	95.5	95.3	93.2	86.1	77.2	79.4	91.8	91.8
Lumber	90.4	99.0	84.5	81.1	84.5	70.7	58.5	69.5	85.8	93.8
Paint and paint materials	81.3	83.4	80.1	79.8	79.5	73.3	71.1	79.4	90.5	94.9
Plumbing and heating	78.5	78.8	75.0	68.9	72.6	67.1	66.8	84.7	88.6	95.0
Structural steel	111.0	113.2	95.0	92.0	90.8	83.1	80.9	83.1	87.3	98.1
Other building materials	92.7	99.1	90.2	90.1	90.3	82.7	79.5	84.8	93.3	97.7

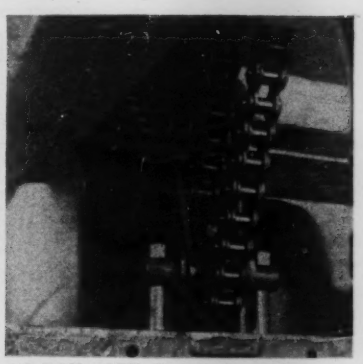
SHOVEL FEATURES
like these COST NO MORE when you buy a BAY CITY



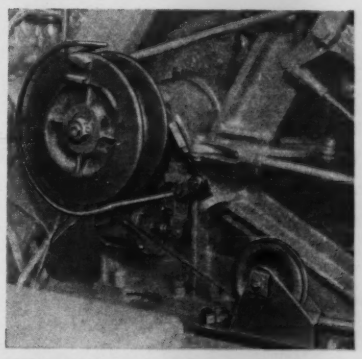
Quiet, powerful helical gears—tandem drums—anti-friction bearings throughout—3 lever control with booster operated clutches—boom foot lugs cast integral with unit-cast alloy steel revolving table—ample room around machinery.



Working time is the only time to count in figuring yardage. Fast, easy travel and steering with BAY CITY design by simply applying pressure on cone clutches that operate brakes. *No jaw clutches or brakes to set.* Automatic propelling chocks hold machine while working.



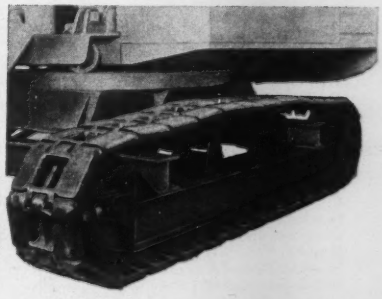
All BAY CITY Shovels from ⅜ yd. up are standard equipped with heavy duty single piece powerful chain crowd mechanism—independent and positive. Automatic chain adjustment maintains proper tension at any boom angle.



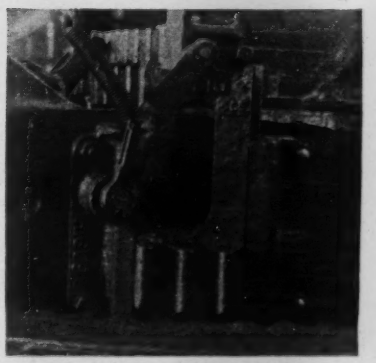
Don't criticize your operator for low production, unless he has the advantage of this exclusive Electric Dipper Trip which adds from 10 to 15% to daily yardage. Push button control on top of swing lever grip just where needed.

. . . because
they are STANDARD

SO many of our new customers—former users of other machines—are so enthusiastic about the operating advantages of the BAY CITY, that we realized maybe it's our fault you do not know about the many money-making features. So for the first time in these pages, we review some of the more important features that result in lower operating and maintenance costs—bigger yardage—easier operation—faster speeds—greater power. Look them over, then write for complete description in Catalog H-1.



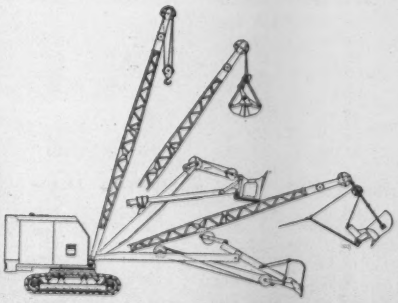
Long, wide crawlers provide low ground bearing pressure at no extra expense and drop forged crawler shoes with drilled pin holes and alloy pins give greater wear, thus reducing one of the largest single items of shovel up-keep. Drop forged crawler rollers and special heat-treated drive sprockets, also standard.



Here is a feature that saves money—if time means money on your job. This sturdy, patented swing lock engages positively in bull gear and will hold in any position of the circle. Operated by foot lever from inside cab.

BAY CITY SHOVELS, Inc., Bay City, Mich.

Export Office:
H. M. Hein, 330 W. 42nd St., New York, N. Y.



FULLY CONVERTIBLE

All BAY CITY machines follow the same general design and are fully convertible without machinery change. Use them as shovel, crane, clam, drag or trench-hoe for bigger performance at lower operating and maintenance cost.

BAY CITY SHOVELS

MATERIALS AND LABOR PRICES

DECEMBER, 1938

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

HIGHER lumber prices are the only major change in the construction material market for December. Short Leaf Southern Pine is up $1.00 per M bd.ft. in Baltimore; up $1.00 to $3.00 in Chicago; up $1.00 to $2.00 in Cleveland and St. Louis; up $2.00 to $3.00 in Kansas City; and off 50c. per M bd.ft. in Atlanta. Douglas Fir is up $1.00 in Baltimore, but remains at November levels in the other reporting cities. Long Leaf Yellow Pine timbers are $5.00 higher in Chicago, $2.00 higher in Baltimore, and $1.00 higher in St. Louis. Fir timbers are up $1.00 in Baltimore.

Cement prices in Minneapolis are 14c. per bbl. lower than quoted in November as the dealers absorbed the 14c. increase reported at that time. Cement is down 3c. per bbl. in Atlanta, and 10c. in Montreal. Sand is off 21c. per ton in Kansas City, and off 5c. per cu. yd. in New York. Ready-mixed concrete is up 25c. in Minneapolis due to heating charges.

Steel reinforcing bars are off 2c. per cwt. in Detroit. Expanded metal lath is $1.00 higher in Detroit and $2.00 higher in New York. Sheetpiling is 15c. lower in San Francisco.

Common and skilled labor rates in the *ENR* 20 cities remain at their October and November levels.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE (Ready Mixed 1:2:4, 50 c.y. or more, delivered)
	Cloth Bags	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	$2.60	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.75
Baltimore	2.31	2.06	1.91	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	7.00
Birmingham	2.55	2.30	1.99	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.75b	2.50b	2.30	1.10	1.10	.80	1.10	1.10	....	....	6.75m
Chicago	2.60	2.35	2.20	2.00‡d	2.00‡d	2.00‡d	2.00‡d	2.00‡d	1.25‡	1.25‡	....
Cincinnati	2.47	2.22	2.07	1.20	1.20	1.30	1.80	1.80	....	....	6.60
Cleveland	1.95	1.70	....	1.45i	1.45i	1.30i	1.70i	1.70i	1.70i	1.70i	6.65i
Dallas	2.30	2.05	1.85	1.60p	1.60p	1.35p	1.69p	1.84p	....	....	6.50
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.03	1.78	1.58	1.05	1.15	.85	1.45	1.45	1.65‡	1.65‡	6.50
Kansas City	2.56	2.31	2.10	1.85	2.30	1.00	1.91	1.91	....	....	7.90n
Los Angeles	2.82b	2.62b	....	1.68	1.68	1.68	1.68f	1.68f	....	....	7.00
Minneapolis	2.86	2.61	....	1.00h	1.00h	.25h	1.00h	1.00h	....	....	7.40j
Montreal	....	....	1.48	...	...	1.25‡	.90‡	1.00‡	....	....	7.60l
New Orleans	2.41	2.16	....	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.25de	1.25de	.60/.70de	1.65de	1.75de	....	....	6.75
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95k
Pittsburgh	2.44	2.19	1.99	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85h	.85h	.75g	.75g	7.50
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	....	....	7.50
Seattle	3.10e	2.85e	....	1.17e	1.17e	1.17e	1.33e	1.33e	....	....	7.30o

‡Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c per ton off, cash 15 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

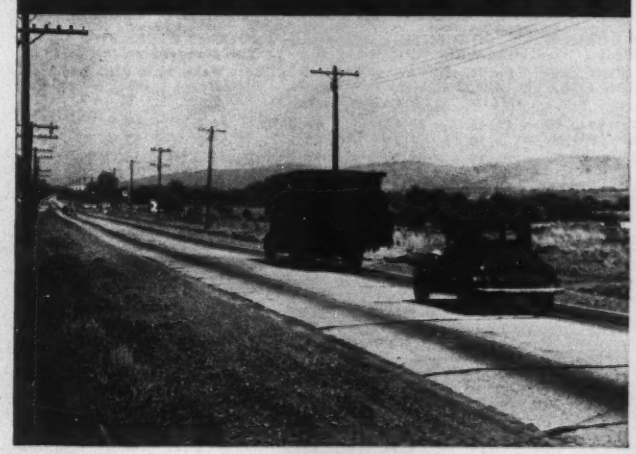
	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn.	1.80	1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind.	1.70	1.65	Steelton, Mimn.	1.80	1.75
Hannibal, Mo.	1.70	1.65	Norfolk, Va.	1.65	1.60	Universal, Pa.	1.65	1.60
Hudson, N. Y.	1.75	1.70	Northampton, Pa.	1.55	1.50	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70
Independence, Kans.	1.70	1.65	North Birmingham, Ala.	1.70	1.65			

LOWER PENINSULA, MICHIGAN. Uniform carload lot cement price established March, 1937.

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT (Per ton, less than 80 penetration)		ASPHALT BINDERS—FLUXES (Per gal., 80–300 penetration)		CUTBACK ASPHALT (Per ton)		ROAD OILS (Per gal.)	ASPHALT EMULSION (Quick-breaking) (Per gal.)	
	Granite per M, lots of 50,000, 4x4x8 in.	Brick per M, 3x4x8½ in., carload lots	Wood per sq. yd., 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$75.00	$39.35	$2.25	$16.60e	$21.80e	$0.0675e	$0.0968e	$.0734he	$.1057he	$0.0584e	$0.0834	$0.0834
Baltimore	140.00	44.00‡	2.50	13.00	18.00	.06	.085	.07h	.10	.....	.....	.....
Birmingham	.....	25.00	.....	18.20	23.20	.0747	.0997	.0834h	.1134h	.....	...	.....
Boston	75.00	47.00	3.00	15.00	20.00	.06	.085	.07h	.10h	.07‡	.09‡	.12‡
Chicago	140.00	49.00	2.50	14.00	18.00	13.00g	17.00g	.06h	.11h	.0325	.08	.11
Cincinnati	112.00	37.50	.....	13.31	17.31	.09	.....	16.00	.....	.051	.078	.....
Cleveland	110.00	37.50	2.85	15.25	20.50	.07	.08	.075h	.085h	.045	.0825	.0925
Dallas	.....	30.50	.....	12.00	17.00	.04	.07	13.00	18.00	.035	.05/.07	.07/.09
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	14.10f	20.00f	14.00g	18.40g	14.00	19.70	.0535	.066	.0995
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077h	.107h	.057	.11	.15
Los Angeles	.....	50.00	.....	6.50b	15.00	6.50b	15.00g	5.50b	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90d	19.20	25.20	.10	.12	19.30	28.80	.056	.....	.....
Montreal	82.50	55.20	3.62	14.60	21.25	.105	.1375	.101h	.121h	.0935	.13	.16
New Orleans	.....	.....	.....	14.00a	19.00a	.055	.085	.06h	.09h	...	.078	.....
New York	.....	68.00	2.90	15.10	20.50	.06	.085	.07h	.10h	.....	.0725	.1025
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06h	.09h	.05	.06	.09
Pittsburgh	115.00	40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	. ...	15.00	20.00	.055	.085	.06h	.09h	.035	.075	.115
San Francisco	.....	70.00	.....	6.50	15.00	6.50g	17.00g	7.00	17.50	.025	.0475	.117
Seattle	.....	60.00c	.....	13.70	20.05	.....	24.10g	9.50/10.50	23.00/24.00	7.75	.0575	.1308

‡Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *j* Mexican. *g* Per ton. *h* Per gallon.



MAINTENANCE COSTS ARE LOW IN NEW JERSEY. Built in 1913, New Jersey's first mile of concrete continues to "take it." In spite of very heavy average traffic, New Jersey's network of concrete roads of varying ages averaged only $169.41 per mile per year for surface maintenance over a recent 7-year period—only 1/3 to 1/6 as much as the next two most economical types.

"WHITE ELEPHANT" ROADS?

Not where CONCRETE *is the standard!*

Roads needing constant maintenance and repairs are aptly called "white elephants."

Because of high maintenance charges for such roads built in the past, some states and counties are finding they have inadequate funds for new construction. Work on needed new roads, bridges, grade separations and other vital improvements is nearly at a standstill. What was once thought to be "low-cost construction" is turning out to be very high-cost construction.

This important statement of principle is now widely recognized:

The ultimate or "annual transportation" cost of a highway is the critical cost. Surface maintenance is so important a cost factor that it may often be a *DECIDING* factor in the selection of design types, in the interest of economy alone.

Concrete Saves Millions in Maintenance

How does concrete stand when subjected to this test? A summary of costs in all states having comparable records available—covering 135,000 miles of state highways—shows that surface maintenance for concrete averages about $103 per mile per year —$88 to $465 *less* than for other surfaces. In general the concrete roads carried the heaviest traffic.

Measured by first cost, length of life, maintenance cost and cost of vehicle operation, concrete is the LOW cost road.

PORTLAND CEMENT ASSOCIATION

Dept. A4d-17, 33 West Grand Avenue, Chicago, Ill.

A National Organization to Improve and Extend the Uses of Concrete

CONCRETE IS THE REAL LOW COST ROAD

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet b	RIVETS ½-in. structural	WIRE NAILS Base	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle bars	Std. spikes c	Tie plates c	Track bolt
Birmingham	$2.10	$2.05	$3.40	$2.45	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.05	3.40	2.45	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.05	3.40	2.45d	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.05	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	2.05	3.40	2.45	....	....	....	....	....	....	....	....
Youngstown	....	2.05	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.15‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45a	2.40a	....	....	2.85a	....	....	....	....	....	....	....
Pacific ports	2.70a	2.50a	....	....	2.90a	....	....	....	....	3.00	2.25	....

‡Delivered. c F.o.b. cars dock. b For rail steel deduct 15c. from billet prices. c Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. d Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¾ in., base price 15 tons or over b New billet	Rail steel	Add $/cwt. for Switch	Del.	EXPANDED METAL LATH Per 100 sq.yd., carload lots Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.74	$2.29	$2.14	.02½	.10	$21.00	$23.00	$1.66	$1.25	$0.1566	$3.04
Baltimore	3.55	2.70	2.55	....	.10	20.50	22.50	1.54	1.17	.1458	2.70
Birmingham	2.10a	2.05	1.90	.02½	.10	19.50	21.50	1.64	1.23	.1548	....
Boston	3.85	2.58	2.43	$20 C.L.	.10	21.00‡	23.00‡	1.60	1.21	.1512	2.99
Chicago	2.10a	2.05	1.90	.03	.05	18.50	20.50	1.51	1.15	.1422	2.40
Cincinnati	3.88	2.31c	2.16c	....	.05	20.50	22.50	1.50	1.14	.1413	....
Cleveland	3.43g	2.05	1.90	.02½	.10	21.50	23.50	1.50	1.14	.1422	....
Dallas	4.15f	2.80	2.65f	....	....	21.00	23.00	1.77f	1.32f	.1674	....
Denver	4.21	3.89	3.74	....	....	23.50	25.50	1.81	1.34	.1710	....
Detroit	3.80‡	2.55	2.40	....	.10	21.50	22.50	1.52	1.16	.1440	2.87½
Kansas City	4.10	2.51c	2.36c	.0	.05	18.50	20.50	1.62	1.22	.1539	2.86
Los Angeles	3.50f	2.65	2.50	.02½	.05	21.50	27.50	1.77	1.32	.1674	3.50
Minneapolis	3.80‡	2.38c	2.23c	.0	.10	21.50	24.50	1.64	1.23	.1548	2.73g
Montreal	3.25	2.65	2.55	....	....	26.68	29.90	2.99	2.08	.314	3.95
New Orleans	3.90	2.69	2.54	.05	.10	21.00	23.00	1.67	1.26	.1584	2.87½
New York	3.75	2.29	2.14	....	.10	20.50	22.50	1.56	1.19	.1476	2.76
Philadelphia	3.40	2.37	2.22	....	....	20.50	22.50	1.55	1.18	.1467	2.72
Pittsburgh	2.10a	2.05	1.90	.02½	.10	21.50	24.50	1.43	1.10	.1350	2.40
St. Louis	3.77	2.29	2.14	.0	.05	23.50	25.50	1.53	1.16	.1449	2.70
San Francisco	3.95	2.50	2.35	.02½	.10	23.50	25.50	1.77	1.32	.1674	3.00
Seattle	2.70e	2.65e	....	....	....	25.50	27.50	1.77	1.32	.1674	2.90e

‡Delivered. a Mill prices. b 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. c 20 tons or over Base. d Mill price plus freight. e F.o.b. dock. f Includes delivery in free delivery zone. g Less than 1 ton, add 30c; 1 to 5 tons, add 10c.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.a	VITRIFIED SEWER PIPE Per foot, 8 in., s.s.	delivered 12 in., s.s.	ASTM 24 in., d.s.	C13-35 36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONCRETE SEWER PIPE Per ft., delivered: ASTM C 14-35 12 in.	24 in.	WROUGHT STEEL PIPE Full standard weight: h 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in., Lap Weld Black %	Galv. %
Atlanta	$46.40	$0.26bc	$0.468bc	$1.69	$4.50c	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	49.80	.30	.55	2.40	6.25	110.00	170.00	.50	1.75	65.5	57.5	63.0	54.5
Birmingham	42.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	52.00	.28	.54	2.475	6.67	136.00‡	196.50‡	.50	2.50	64.1	56.1	61.6	53.1
Chicago	50.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	49.70	.203	.3915	1.665	5.0225	75.00	120.00	.60	1.90	65.9	57.9	63.4	54.9
Cleveland	51.24	.175	.3375	1.35	4.2025	69.00	108.00	.34	1.45	67.8	59.8	65.3	56.8
Dallas	55.20	.265	.477	1.89	4.70	.....	.....	.46	1.57	59.9	51.9	57.3	48.3
Denver	57.60	.39†	.50†	2.10†	....	190.00	220.00	....	....	58.4	50.4	55.7	47.2
Detroit	51.24	.147	.2835	1.215	4.70	66.45	111.40	.25	1.125	66.3	58.3	63.8	55.3
Kansas City	52.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	52.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8
Minneapolis	54.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.59	.90	3.15	....	135.00‡	260.00‡	.48	1.92	....	....	....	....
New Orleans	48.38	.26	.48	1.69	....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	49.20	.29	.57	2.25	6.15	.....	.....	.64	1.70	64.9	56.8	62.4	53.9
Philadelphia	47.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	52.60	.182†	.351†	1.44†	4.20	97.80	154.20	.85g	2.00g	68.5i	60.5i	66.0i	57.5i
St. Louis	49.48	.28	.504	2.016	3.96	85.00	170.00	.80	2.00	65.1	57.1	62.0	53.5
San Francisco	52.00	.3275d	.5895d	2.358	5.895	107.25	178.75	.45	2.50	....	....	....	....
Seattle	52.35	.35	.63	2.52	6.30	72.00	175.00f	.60	1.60f	....	....	....	....

‡ Delivered. † F.o.b. a B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $46.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. b Double strength. c List to dealer. d List. f Less 5% for cash. g Culvert pipe. h Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¾ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92.

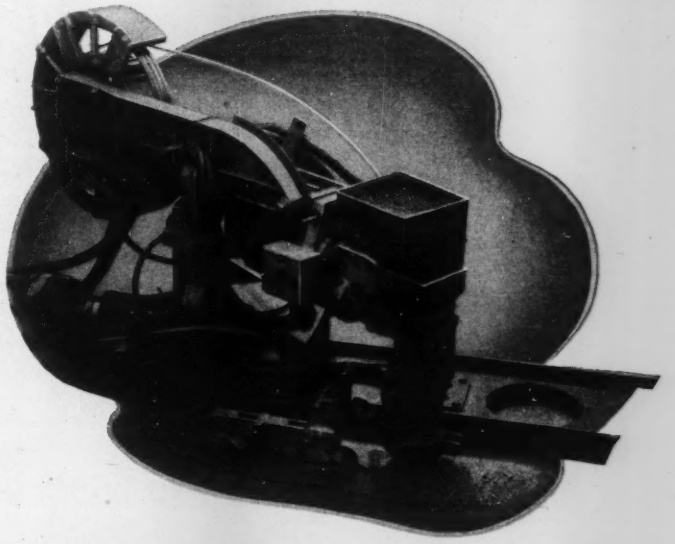
i Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld — 1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld — 2½ in. to 3½ in. black 31½, galv. 17½; 4 in. to 8 in. black, 32½ galv. 20.

The Right Process for the Job at Hand

LINDE'S ability to help its customers apply the right process to the job at hand—and apply it the best possible way—frequently counts more toward making profits for the customer than does the price of the materials used.

There are many Linde products and processes to speed up production, improve results, and lower costs. Yet even more important, is Linde's accurate knowledge of how best to adapt them to industry's actual needs.

If you are not certain that your operations are realizing full benefit of Linde service, we suggest you talk it over with a Linde man. Any representative can tell you how the Linde organization is geared to bring into your plant the engineering co-operation that means control of costs and efficient application of Linde products. The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, Offices in principal cities.



UNIONMELT WELDING is a revolutionary electric process that is fully automatic. With it, high-quality welds can be made in one pass at amazing speeds. It is being used successfully in many different industries to make better products in less time and at lower cost. The illustration shows a Unionmelt welding head speeding the fabrication of a barge. Linde research developed this process—and Linde engineers can help you use it.

THERE IS MORE TO **Linde** *THAN "EVERYTHING FOR WELDING AND CUTTING"*

MACHINE FLAME-CUTTING—One of the most successful methods of shaping steel. Linde has the machines, the gases, and—what counts more—the organization and the knowledge to help you apply the process profitably.

FLAME-HARDENING — A means of imparting a hard surface "case" to make metal parts subject to wear last longer. Linde engineering facilities and process data can help you utilize this process to best advantage at lowest costs.

LINDEWELD MULTI-FLAME — Still another Linde process providing a fast, money-saving means of joining pipe with strong, ductile welds. Behind your operators, Linde Service and research stand, ready to help when needed.

LINDE OXYGEN · NITROGEN · HYDROGEN · RARE GASES AND MIXTURES · UNION CARBIDE
PREST-O-LITE ACETYLENE · OXWELD APPARATUS AND SUPPLIES · UNIONMELT WELDING

The words "Linde," "Union," "Prest-O-Lite," "Oxweld" and "Unionmelt" are trade-marks of Units of Union Carbide and Carbon Corporation.

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR									LONG LEAF Y. P.		PLYWOOD	
	All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)									Merchantable grade up to 20 ft.		Rail freight increment (See note for base price)	
	1x6, a,g	1x8, a,g	2x4, a,g	2x6, a,g	2x8, a,g	2x10, a,g	3x12, a,h	6x12, a,h	12x12, a,h	2x12, a,h	12x12, a,h	⅜"	½"
Atlanta	$19.00	$19.00	$19.00	$19.00	$19.50	$19.50	$27.00	.....	.....	$40.00	$50.00	$17.75	$21.60
Baltimore	24.00	25.00	24.00	23.00	25.00	27.00	39.00	.....	.....	64.00	68.00	17.35g	21.15g
	31.00	*31.00*	*31.00*	*30.00*	*31.00*	*31.00*	*39.00*	*$39.00*	*$39.00*	.....	.....	.....	.....
Birmingham	19.00	19.00	19.00	19.00	19.00	20.00	30.00	30.00	30.00	.....	.....	16.25	19.85
	22.00	22.00	26.00	26.00	26.00	36.00	54.00	.....	.....	48.00	53.00	.....	.....
Boston	28.00[3]	28.00[3]	32.00[3]	32.00	48.00[3]	60.00[3]	72.00[3]	.....	.....	72.00	72.00	17.35g	21.15g
	28.00	*28.00*	*30.00*	*30.00*	*32.00*	*32.00*	*35.00*	*40.00*	*40.00*	.....	.....	.....	.....
Chicago	28.00	29.00	31.00	30.00	30.00	30.00	45.00	.....	.....	75.00	75.00	15.15	16.05
	32.00	*33.00*	*36.00*	*36.00*	*36.00*	*36.00*	*41.00*	*39.00*	*39.00*	.....	.....	.....	.....
Cincinnati	23.75	23.75	25.00	23.25	24.25	26.50	37.50	.....	.....	46.00	49.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	*39.50*	*39.50*	*39.50*	.....	.....	.....	.....
Cleveland	30.00	31.00	36.00	31.00	32.00	40.00	48.00	.....	.....	52.00	62.00[3]	16.65	20.25
Dallas	28.50	31.50	30.00	26.00	28.50	31.50	55.00	54.00	54.00	64.50	71.00	13.90	16.95
Denver	41.00[4]	39.00[4]	43.00[4]	42.00[4]	42.00[4]	47.00[4]	45.00[4]	60.00[4]	64.50[4]	.....	.....	9.90	12.05
Detroit	24.00	24.00	25.00	25.00	26.00	26.00	35.00	.....	.....	30.50	40.00	16.25	19.85
	.....	.....	.....	.....	.....	*36.00*	*38.00*	*40.00*	*40.00*	.....	.....	.....	.....
Kansas City	27.00	28.50	28.00	26.00	28.00	30.00	35.00	.....	.....	55.00	58.00	12.25	14.95
	28.00	*28.00*	*28.00*	*28.00*	*28.00*	*29.00*	*34.00*	*35.00*	*35.00*	.....	.....	.....	.....
Los Angeles	*35.00*	*35.00*	*35.00*	*35.00*	*36.00*	*36.00*	*42.00*	*46.00*	*42.00*	.....	.....	9.35gh	11.35gh
Minneapolis	43.00[3]	43.00[3]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
	34.00	*34.00*	*35.00*	*35.00*	*35.00*	*35.00*	*55.00*	*55.00*	*55.00*	.....	.....	.....	.....
Montreal	*45.00*	*45.00*	*49.00*	47.00	48.00	58.00	84.00	.....	.....	135.00	145.00	.....	.....
	40.00	*40.00*	*40.00*	*40.00*	*40.00*	*41.50*	*42.00*	*41.00*	*40.00*	.....	.....	.....	.....
New Orleans	22.00	22.00	20.00	19.00	20.00	22.00	42.00	.....	.....	58.00	65.00	13.90	16.95
	26.00	*26.00*	*28.00*	*29.00*	*32.00*	*30.00*	*32.00*	.....	.....	.....	.....	.....	.....
New York	35.00	36.00	35.00	36.00	36.00	37.00	40.00	.....	.....	75.00	77.50	17.35g	21.15g
	.....	.....	*40.00*	*40.00*	*40.00*	*40.00*	*40.00*	*42.50*	*42.50*	.....	.....	.....	.....
Philadelphia	23.50	24.00	25.00	25.00	26.00	26.50	28.50	.....	.....	54.00	56.00	17.35g	21.15g
	34.00	*35.00*	*38.00*	*37.25*	*36.50*	*36.50*	*41.75*	*31.50*	*31.50*	.....	.....	.....	.....
Pittsburgh	38.10	39.90	47.05	42.00	45.65	46.90	59.70	.....	.....	.....	.....	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis	32.50	33.00	31.50	30.50	31.50	33.00	49.00	*51.00*	*51.00*	73.00	74.00	13.90	16.95
San Francisco	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*19.00*	*23.00*	*23.00*	*23.00*	.....	.....	7.30g	8.90g
Seattle	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*20.00*	*26.00*	*26.00*	*26.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Pine. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off.

Note: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1000 sq. ft. surface. Base price — Seattle: ½", $66.94; ⅝", $76.39. For other centers add rail freight increment from table for proper size. Add: for form oil treatment, $2.50 per M. sq. ft.; for mineral paint sealed edges, $1.00 per M; for resin dipped treatment, $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from latest jobbers list, Sept. 15, 1928 Single or Double Thickness		EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 2001b. lots*	
	A quality	B quality		
Atlanta	88%	88%	$0.16	
Baltimore	88%	87%	.16	
Birmingham	89%	90%	.115	
Boston	87%	89%	.16	
Chicago	79%*c*	79%*c*	.16	
Cincinnati	89–10%	91–10%	.16	
Cleveland	85–10%	85–10%	.20	
Dallas	80%	80%	.175	
Denver	85%	86%	.16*d*	
Detroit	87–10%	89–10%	.16	
Kansas City	86–10%	87–10%	.165	
Los Angeles	90%*e*	90@40%	.1675	
Minneapolis	87–10%	88–10%	.165	
Montreal	70–10%*b*		.18†	
New Orleans	86%	88%	.17	
New York	89%	90%	.23*e*	
Philadelphia	89–10%	90–10%	.16	
Pittsburgh	86%	87%	.1525	
St. Louis	86–10%	87–10%	.165	
San Francisco	78%	83%	.165	
Seattle	86%	90%	.1675	

Price of 60% Ammonia Gelatin is $0.015 per lb higher than 40%

a Disc. from list Aug. 1, 1929. *b* Also less 6% tax exemption. *c* Discounts from jobbers list, Nov. 16, 1938.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *d* F.o.b. Louviers, Colo. *e* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	2001b. lots
E. of the Miss., except Fla.	$0.115	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla.	.12 –.13	.145 –.16	.165 –.18
Rocky Mtn. States	.12 –.1425	.14 –.155**	.16 –.175**
Pacific N. W. States	.1175–.13	.1475–.16	.1675–.18
Pacific S. W. States	.1150–.1275	.145 –.1525	.165 –.1725

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Short Leaf — Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.—2 ft. from butt.	6 in.	50 to 59 ft.	.225	.24
12 in.—2 ft. from butt.	6 in.	60 to 69 ft.	.23	.255
14 in.—2 ft. from butt.	6 in.	50 to 69 ft.	.24	.265
14 in.—2 ft. from butt.	6 in.	70 to 79 ft.	.28	.275
14 in.—2 ft. from butt.	5 in.	80 to 85 ft.	.40	.415
14 in.—2 ft. from butt.	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:

		6" x 8" x 8' Untr.	6" x 8" x 8' Tr.	7" x 9" x 8' 6" Untr.	7" x 9" x 8' 6" Tr.
Boston	Oak	$1.10	....	$1.60	....
	Pine	1.25	$1.90*a*	1.85	$2.75*a*
New York	S.L. Sap Pine	1.05/1.15	1.90*g*	1.30	2.35*g*
	Mixed Oak	1.50	....	1.85	....
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.67*ae*	....	2.05*ac*
	Oak	....	1.55*d*	....	1.90*d*
	Southern Pine	....	1.50*a*	....	1.95*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.05	....	1.35	....
	Red Oak	1.00	1.35*a*	1.30	1.75*a*
	Sap Pine or Cypress	.90	....	1.20	....
San Francisco	Douglas Fir	.80*bef*	....	....	1.85*aef*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

Tr.—Treated; Untr.—Untreated. *a* Creosoted. *b* 6" x 8" x 8' 6" *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle. *g* Dense pine

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00–2.85
Chlorine cylinders, per lb. delivered	.055
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalised with points of competition, per ton	22.00–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb	4.50

For Dependable Economy and Long Life ..... use AMCRECO Pressure Creosoted PILES and TIMBER
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ADDRESS INQUIRIES TO CHICAGO, ILL., OR LOUISVILLE, KY.
TIES • PILES • POLES • TIMBER

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED			STRUCTURAL CLAY TILE—LOAD BEARING—SCORED			BRICK		LIME		
	Per M, lots of 2,000 pieces or over,			Per M, lots of 2,000 pieces or over,			Per M, in quantity,		Per ton,	n paper	carload lot
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	Pulverized or lump
Atlanta	$100.00	$120.00	$200.00	$230.00	$240.00	$250.00	$11.50	$16.00	$24.00	$15.50	$15 50
Baltimore	74.00	80.00	165.00	195.00	250.00	300.00	13.00*k*	16.00*k*	14.00	15.00	22 00
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	3.00*e*	1.75*e*	2.25*ls*
Boston	90.75*ab*	96.80*ab*	181.50*ab*	205.70*ab*	266.70*ab*	304.80*a*	17.00*i*	20.00*i*	19.00	13.00	3.10*lp*
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	15.00	14.40	12.20
Cincinnati	56.45	60.40	115.25	138.70	166.50	206.40	16.00	16.00	15.90	13.00	.....
Cleveland	52.50	56.00	105.00	126.00	170.00	194.50	15.50	15.50	15.20*j*	12.80*j*	2.65*jm*
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	78.50	88.00	141.50	166.50	196.00	225.50	12.00	15.50	28.00*j*	17.00*j*	35 00
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	16.00	17.00	13.50	11.25	11.25
Kansas City	64.50	66.50	81.00*c*	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	12.00	14.00	18.70	.....	19.70
Minneapolis	80.35	85.70	146.00	192.85	176.20*d*	245.20*d*	13.10	15.10*g*	21.00	16.00	19.00
Montreal	64.00*a*	77.00*a*	141.00*a*	77.00*a t*	128.00*a*	.....	21.00	31.00	24.60	16.00	10.50*l*
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00*h*	93.00*h*	128.00*h*	193.30*h*	238.80*h*	295.60*h*	13.00	.....	20.00	15.00	18.00
Philadelphia	77.40	82.50	154.70	185.70	229.90	284.60	11.00*s*	18.00*s*	15.50*g*	10.05	10.55
Pittsburgh	58.40	62.40	116.85	124.00	155.00	193.75	15.00	25.00	17.70	15.20	2.57*m*
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30*lm*
San Francisco	84.00	94.50	225.00	.....	.....	.....	14.00	17.00	.55*e*	.40*e*	2.05*m*
Seattle	100.00	110.00	220.00	.....	.....	.....	17.50*f*	17.50*f*	20.00*s*	20.00*s*	20.00*s*

F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb net. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 15-ton cars *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

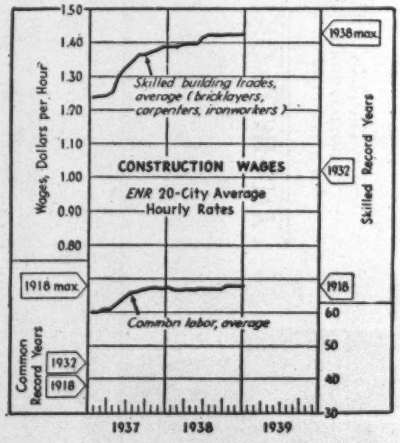
PAINT, ROOFING—F.O.B. CARLOAD LOTS

	RED LEAD	WHITE LEAD	READY-MIXED PAINT			ROOFING SUPPLIES Carload lots f. o. b. factory				
	Per 100 lb. in 600-lb. (Approx.) bbl. Dry *a*	Per 100 lb. in oil	Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch, 350 lb. bbl. per ton
Atlanta	$8.75	$11.125	$1.30	$2.25	$1.20	$1.71	$1.65	$1.65	$.36	$26.00
Baltimore	8.50	10.75	1.45	2.25	1.70	2.16	2.75	2.75	.40	27.50
Birmingham	8.75	11.125	2.35	2.35	1.85	2.07	2.03	2.03	.45	30.37
Boston	8.50	10.75	1.80‡	2.20‡	1.80‡	1.75‡	1.90*k*‡	1.90*k*‡	.40‡	20.00‡
Chicago	8.50	10.75	1.80	....	....	1.53*k f*	1.59*k f*	1.59*k f*	.26*f*	23.00*f*
Cincinnati	8.50	10.75	1.45	2.50	1.40	2.40	2.39*k*	2.39*k*	.36	21.00
Cleveland	8.50	10.75	1.90	2.60	1.40	1.40	1.45*k*	1.45*k*	.36	21.00
Dallas	8.50	11.50	1.80	1.95	....	2.75*k*	2.50*k*	2.50*k*	.60	.....
Denver	9.00	11.25	....	....	....	2.45	4.00	3.00	.35	28.00
Detroit	8.50	10.75	2.00	3.00	1.75	2.40	3.25	3.25	.35	29.00
Kansas City	8.50	10.875	2.15*g*	2.40*g*	1.67*g*	1.93	2.09	2.09	.25	25.00
Los Angeles	8.75	11.00	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	8.50	10.875	....	....	....	1.40*i*	1.45*k i*	1.45*k i*	.29	21.00
Montreal	9.75	9.00	2.25	2.80	2.35	3.05	1.85	2.15	.90	1.80*j*
New York	8.50	10.75	1.80	2.45	1.48	1.40	1.45*k*	1.45*k*	.23	24.00
Philadelphia	8.50	10.75	.....	.....	.....	1.92*e*	1.99*k e*	1.99*k e*	.41*e*	21.00
Pittsburgh	8.50	10.75	1.05	1.95	.80	1.95	1.94*k*	1.94*k*	.34	26.00
St. Louis	8.50	10.75	1.70/1.90	2.50/2.75	1.50/1.90	1.40	1.45	1.45	.23	21.00
San Francisco	8.75	10.75	1.80	2.75	1.10/2.00	1.66	1.90	1.90	.325	20.50
Seattle	8.75	11.00	1.80	2.85	2.20	2.02	1.43/2.10	2.60	.54	24.10*k*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% maximum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Per 100 lb. *k* Asphalt pitch

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.25	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.50	1.50	1.25	.50	.50
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40*a*	.30/.40*a*
Boston	1.50	1.375	1.50	1.375	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.625	1.70	1.025	1.025
Cincinnati	1.00/1.625	.70/1.35	1.40	1.00/1.40	1.00/1.625	.60/.75	.60/.75
Cleveland	1.625	1.375	1.50	1.50	1.50	.90	.90
Dallas	1.50	1.25	1.25	1.00	1.50	.40	.40
Denver	1.50*b*	1.50*b*	1.43*b*	....	1.43*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.80	.60/.80
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.45/.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*e*	.85	.85
New Orleans	1.00	1.00	1.25	1.00	1.00	.40	.40
New York	1.886*b*	1.75*b*	1.925	2.00*b*	2.00*e*	1.031	.875/.95
Philadelphia	1.65	1.25	1.50	1.50	1.565	.60	.60
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.25	1.75	1.57/2.00	1.58	.45/.875	.45/.875
San Francisco	1.75*e*	1.25	1.50	1.50	1.65*e*	.81	.65
Seattle	1.60*e*	1.25*e*	1.50*e*	1.50*e*	1.60*e*	.90*e*	1.00*e*
Montreal	.70	.60	.60	.55	.67	.35	.40



a PWA *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement.

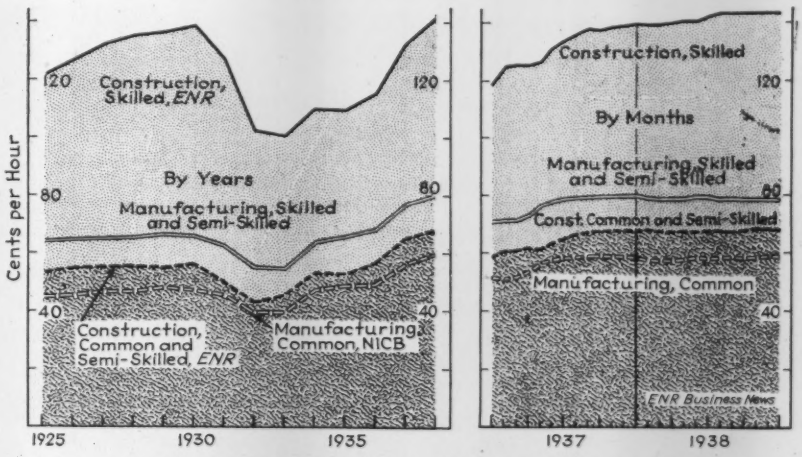
ENR Skilled Average: (Bricklayers, Carpenters, Iron workers) $1.427
ENR Common Average: $0.682

Construction Wage Rates and Trends

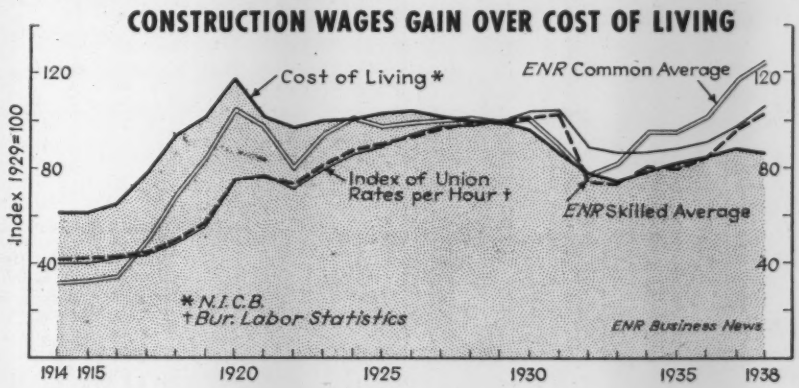
THE rise in construction labor rates that has continued unbroken since 1932 was checked last year. Unskilled rates paid in twenty leading cities averaged 67.8c. for 1938, as compared with 64.5c. for 1937, but showed only a fraction of a cent change throughout the year. Skilled wages in the same cities averaged $1.41 for last year against $1.32 for 1937, but likewise showed a slight range for 1938, 3.7c. to be exact. However, both skilled and common rates stood at record high levels at the end of 1938, according to the twenty-city average, $1.427 and 68.2c., respectively.

As shown in the accompanying chart, construction wage trends followed closely those of manufacturing in 1938, though the spread between skilled areas in construction and those in manufacturing is slowly widening. In comparison with 1929 rates as a base, common wages in construction have risen faster than have skilled construction and all union rates, as can be noted in the chart at the right. Construction and union trades wages have risen above the cost of living on a 1929 comparison, gaining considerably in 1938 as living costs in general declined somewhat from their 1937 level.

RISE IN LABOR RATES CHECKED



CONSTRUCTION WAGES GAIN OVER COST OF LIVING



Construction Wages—Rates per Hour

20 Cities Average Reported by Engineering News-Record

Skilled Labor†*

	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
J	$1.16	$1.21	$1.24	$1.28	$1.34	$1.35	$1.37	$1.37	$1.15	$0.989	$1.054	$1.108	$1.119	$1.22	$1.39	$1.43
F	1.16	1.21	1.24	1.32	1.34	1.35	1.38	1.37	1.11	.996	1.062	1.104	1.119	1.24	1.39	1.43
M	1.16	1.21	1.24	1.32	1.34	1.35	1.38	1.36	1.11	.991	1.069	1.092	1.132	1.25	1.40	1.43
A	1.17	1.22	1.25	1.30	1.35	1.35	1.38	1.36	.95	.997	1.084	1.093	1.134	1.26	1.40	1.44
M	1.20	1.22	1.26	1.31	1.36	1.35	1.38	1.36	.96	.998	1.101	1.081	1.138	1.30	1.40	....
J	1.21	1.23	1.27	1.33	1.35	1.36	1.38	1.32	.99	.994	1.101	1.074	1.138	1.33	1.41	....
J	1.20	1.22	1.27	1.33	1.35	1.36	1.38	1.23	1.00	.985	1.104	1.077	1.150	1.35	1.43	....
A	1.20	1.23	1.28	1.34	1.35	1.37	1.39	1.19	.98	.986	1.110	1.088	1.159	1.37	1.43	....
S	1.20	1.23	1.28	1.34	1.35	1.37	1.39	1.19	.99	1.016	1.119	1.088	1.159	1.37	1.43	....
O	1.21	1.23	1.29	1.33	1.35	1.37	1.39	1.17	.98	1.029	1.120	1.104	1.176	1.38	1.43	....
N	1.21	1.23	1.29	1.34	1.35	1.37	1.39	1.16	.97	1.037	1.120	1.101	1.178	1.38	1.43	....
D	1.21	1.24	1.29	1.33	1.35	1.37	1.39	1.15	.98	1.062	1.120	1.101	1.180	1.39	1.43	....
Aver.	**1.19**	**1.22**	**1.27**	**1.32**	**1.35**	**1.36**	**1.38**	**1.27**	**1.02**	**1.006**	**1.097**	**1.093**	**1.149**	**1.32**	**1.41**	....
Mfg. (1)	.644	.644	.651	.656	.659	.668	.662	.634	.559	.55	.642	.662	.685	.78	.80	....

Common Labor*

	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
J	$0.54	$0.55½	$0.54	$0.55½	$0.55	$0.559	$0.5628	$0.5384	$0.4524	$0.4271	$0.5158	$0.5376	$0.547	$0.603	$0.680	$0.682
F	.54	.54	.54	.55½	.54½	.564	.5628	.5428	.4521	.4285	.5268	.5241	.547	.603	.675	.680
M	.55	.54½	.54½	.56	.54½	.5509	.5610	.5371	.4358	.4272	.5268	.5243	.547	.612	.675	.680
A	.55	.54½	.54½	.56	.55	.529	.5646	.5359	.4122	.4343	.5343	.5255	.552	.612	.677	.683
M	.56	.54	.55	.55½	.55	.5315	.5628	.5394	.4105	.4442	.5343	.5233	.558	.627	.673	....
J	.56	.53	.55	.55½	.55½	.534	.5628	.5394	.4121	.4393	.5343	.5269	.564	.644	.677	....
J	.56	.53	.55½	.55½	.55½	.5296	.5615	.4721	.4114	.4430	.5300	.5289	.563	.662	.677	....
A	.56	.53	.55½	.55½	.5607	.5353	.5615	.4634	.4220	.4430	.5300	.5285	.569	.668	.677	....
S	.56	.53	.55½	.55½	.5607	.5496	.5609	.4665	.4308	.4524	.5349	.5285	.569	.673	.677	....
O	.56	.54	.55	.54½	.5628	.5496	.5596	.4584	.4308	.5057	.5363	.5285	.583	.676	.682	....
N	.56	.54	.55½	.54½	.5653	.5603	.5587	.4559	.4260	.5102	.5388	.5275	.583	.678	.682	....
D	.56½	.54	.55½	.55	.5628	.5653	.5503	.4534	.4273	.5202	.5413	.5275	.586	.678	.682	....
Aver.	**.555**	**.538**	**.548**	**.554**	**.5558**	**.5465**	**.5607**	**.5002**	**.4289**	**.4562**	**.5319**	**.5276**	**.564**	**.645**	**.678**	....
Mfg. (2)	.459	.455	.461	.472	.474	.486	.478	.461	.401	.401	.478	.494	.498	.568	.584	....

Construction Wages

	Skilled Aver.†	Common
1910	$0.525	$0.179
1911	.534	.179
1912	.542	.182
1913	.555	.19
1914	.565	.177
1915	.57	.182
1916	.58	.192
1917	.61	.281
1918	.68	.38
1919	.78	.466
1920	1.05	.579
1921	1.06	.54
1922	1.01	.442
1923	1.10	.518

NOTES:

† *ENR* Skilled Averages represents rates for bricklayers, carpenters, iron workers.

(1) Skilled and Semi-skilled.

(2) Unskilled.

Both represent earnings per hour as reported by N. I. C. B.

* Checked monthly. Reported in first issue of *ENR* each month.

Wage Rates per Hour
New York City

	Carpenters, 10 Hr. Day	Bricklayers, 8 Hr. Day	Masons' Laborers, 8 Hr. Day	Common Laborers, 10 Hr. Day	Structural Iron-Workers
1874	$0.23	$0.43	$0.18	$0.14	.....
1875	.22½	.37	.18	.14	.....
1876	.21	.31	.17	.14	.....
1877	.20	.31	.15	.12	.....
1878	.18	.31	.15	.11	.....
1879	.17	.31	.16	.11	.....
1880	.18	.34	.18	.12	.....
1881	.19	.46	.21	.13	.....
1882	.21	.50	.22	.15	.....
1883	.21	.50	.23	.13	.....
1884	.21	.50	.22	.13	.....
1885	.20	.50	.22	.13	.....
1886	.21	.50	.23	.13	.....
1887	.21	.50	.20	.14	.....
1888	.22	.50	.16	.12	.....
1889	.22	.50	.23	.13	.....
	8 Hr. Day			9 Hr. Day	
1890	.43	.47	.28	.14	.....
1891	.43	.47	.28	.14	.....
1892	.44	.50	.29	.14	.....
1893	.43	.50	.30	.14	.....
1894	.44	.50	.30	.14	.....
1895	.43	.50	.30	.14	.....
1896	.44	.50	.30	.14	.....
1897	.44	.50	.29	.14	.....
1898	.44	.50	.30	.14	.....
1899	.45	.55	.33	.14	.....
1900	.50	.56	.33	.14	.....
1901	.50	.59	.33	.19	.....
1902	.51	.65	.36	.17	.....
1903	.56	.65	.36	.16	.....
1904	.53	.65	.36	.19	.....
1905	.54	.70	.36	.20	.....
1906	.58	.70	.38	.21	.....
				—8 Hr. Day—	
1907	.62½	.70	.37½	.22	$0.60
1908	.62½	.70	.37½	.22	.60
1909	.62½	.70	.37½	.22	.60
1910	.62½	.70	.37½	.22	.62½
1911	.62½	.70	.37½	.22	.62½
1912	.62½	.70	.37½	.23	.62½
1913	.62½	.70	.37½	.22½	.62½
1914	.62½	.75	.37½	.22½	.62½
1915	.62½	.75	.37½	.25	.62½
1916	.62½	.75	.37½	.25	.66
1917	.69	.75	.42½	.30	.68
1918	.69	.81	.47	.40½	.80
1919	.75	.87½	.52½	.40½	.87½
1920	1.12½	1.25	.77½	.75	1.12½
1921	1.12½	1.25	.87½	.60	1.12½
1922	1.12½	1.25	.87½	.60	1.12½
1923	1.12½	1.50	.95	.61½	1.12½
1924	1.31½	1.50	1.00	.68½	1.29
1925	1.31½	1.50	1.00	.65½	1.46½
1926	1.46	1.64½	1.07	.81½	1.60
1927	1.50	1.75	1.12½	.90½	1.75
1928	1.50	1.75	1.12½	.90½	1.75
1929	1.55	1.84	1.15	.98½	1.81
1930	1.65	1.92½	1.03½	1.03½	1.92½
1931	1.45	1.71½	1.02½	.65½	1.92½
1932	1.33	1.47	1.00	.64½	1.67½
1933	1.37½	1.57½	.91	.72½	1.65
1934	1.40	1.53	.82½	.84½	1.62
1935	1.40	1.50	.82½	.68	1.65
1936	1.40	1.50	.82½	.65	1.58
1937	1.60	1.73	.91	.76	1.79
	—7 Hr. Day—				
1938	1.75	1.88½	.99½	.91½	1.92½
			1937 by Months		
Jan.	1.40	1.50	.82½	50 /80	1.65
Feb.	1.40	1.50	.82½	50 /80	1.65
Mar.	1.40	1.50	.82½	50 /80	1.65
Apr.	1.40	1.50	.82½	50 /80	1.65
May	1.40	1.50	.95	60 /80	1.65
June	1.75*	1.88½*	.95	60 /85	1.65
July	1.75	1.88½	.95	60 /85	1.92½
Aug.	1.75	1.88½	.95	60 /85	1.92½
Sep.	1.75	1.88½	.95	87½/95	1.92½
Oct.	1.75	1.88½	.95	87½/95	1.92½
Nov.	1.75	1.88½	.95	87½/95	1.92½
Dec.	1.75	1.88½	.95	87½/95	1.92½
			1938 by Months		
Jan.	1.75	1.88½	.95	87½/95	1.92½
Feb.	1.75	1.88½	.95	87½/95	1.92½
Mar.	1.75	1.88½	.95	89½/95	1.92½
Apr.	1.75	1.88½	.95	87½/95	1.92½
May	1.75	1.88½	.95	87½/95	1.92½
June	1.75	1.88½	1.03	87½/95	1.92½
July	1.75	1.88½	1.03	.87½/95	1.92½
Aug.	1.75	1.88½	1.03	.87½/95	1.92½
Sept.	1.75	1.88½	1.03	.87½/95	1.92½
Oct.	1.75	1.88½	1.03	.87½/95	1.92½
Nov.	1.75	1.88½	1.03	.87½/95	1.92½
Dec.	1.75	1.88½	1.03	.87½/95	1.92½
			1939 by Months		
Jan.	1.75	1.88½	1.03	.87½/95	1.92½
Feb.	1.75	1.88½	1.03	.87½/95	1.92½
Mar.	1.75	1.88½	1.03	.87½/95	1.92½
Apr.	1.75	1.88½	1.03	.87½/95	1.92½

* Start of 7-hour day.

INDEX OF UNION HOURLY WAGE RATES IN BUILDING TRADES (1929 = 100)

Industrial Relations Division
U. S. Department of Labor, Bureau of Labor Statistics

Year	All Building Trades	Journeymen	Helpers & Laborers	Bricklayers	Carpenters	Cement Finishers	Electricians (Inside Wiring)	Engineers (Portable & Hoisting)	Glaziers	Lathers	Painters	Plasterers	Plumbers & Gas Fitters	Sheet-Metal Workers	Steam & Sprinkler Fitters	Stonemasons	Structural Ironworkers	Building Laborers	Hod Carriers
1907	31.5	31.7	30.7	37.9	32.0	38.5	31.3	.....	.....	.....	27.5	39.9	37.8	33.8	33.8	34.7	31.8	35.0	33.1
1908	33.5	33.8	32.1	38.9	34.0	38.4	34.2	.....	.....	.....	30.5	39.8	38.2	34.5	34.2	35.2	34.7	35.2	33.2
1909	35.1	35.5	33.2	39.7	35.9	39.6	35.3	.....	.....	.....	32.6	40.1	38.8	34.7	38.9	35.3	37.2	35.3	33.3
1910	36.5	37.0	34.3	40.4	37.6	40.0	36.3	.....	.....	.....	34.6	40.5	39.1	35.7	36.1	35.6	39.5	36.7	33.8
1911	37.1	37.6	34.5	40.4	38.1	41.5	36.7	.....	.....	.....	35.3	40.8	41.4	36.8	37.3	36.0	40.5	36.8	34.1
1912	37.9	38.5	34.8	41.0	38.9	41.5	37.1	41.8	.....	39.4	35.7	41.6	41.6	37.6	37.9	36.4	41.2	37.2	34.3
1913	38.8	39.4	35.8	41.7	39.5	42.5	37.9	43.0	.....	40.3	37.3	42.0	43.0	39.3	39.3	37.6	42.5	38.8	34.8
1914	39.6	40.3	36.2	42.8	40.1	42.9	39.1	43.6	.....	41.0	38.5	42.2	43.6	40.7	40.0	38.7	43.3	39.2	35.2
1915	39.9	40.6	36.5	42.9	40.6	43.3	39.9	43.6	.....	41.5	38.7	42.4	43.9	41.3	40.9	39.1	43.3	39.4	35.4
1916	41.2	42.0	37.7	43.3	41.8	43.7	40.7	44.1	.....	42.7	42.3	43.9	44.3	42.0	41.7	39.7	44.0	41.2	36.5
1917	43.8	44.3	41.4	44.8	45.5	46.2	43.3	46.5	.....	44.4	43.6	45.2	45.8	43.8	43.3	41.2	46.6	45.5	40.7
1918	48.6	49.0	48.0	48.1	50.5	51.0	48.2	53.2	45.9	47.9	48.1	47.6	50.6	51.3	47.3	45.2	53.4	53.4	47.5
1919	55.7	56.0	55.5	53.4	58.2	57.2	55.2	58.3	49.1	53.3	56.3	54.9	57.2	56.6	53.2	50.7	60.1	60.5	55.6
1920	75.2	74.9	80.5	72.8	77.8	77.7	72.8	75.5	71.0	76.0	76.7	71.7	74.0	75.9	70.2	70.7	76.2	87.7	80.8
1921	76.6	76.3	81.3	72.3	78.4	80.3	75.4	76.7	72.2	77.2	78.9	75.6	77.4	78.7	71.1	72.4	77.6	88.2	81.2
1922	71.8	71.9	74.0	70.4	72.7	74.5	71.1	72.2	72.4	72.5	73.8	72.7	71.9	73.0	69.5	67.4	70.5	82.8	67.3
1923	79.4	79.2	78.5	79.7	81.0	81.5	73.8	79.8	76.7	80.1	81.0	81.0	79.4	78.6	72.9	79.7	75.1	84.4	73.5
1924	85.7	85.6	84.9	84.3	86.7	90.1	82.4	84.8	80.9	86.4	85.3	90.6	86.6	86.3	83.6	84.5	85.0	93.9	76.8
1925	89.0	88.8	87.7	89.2	88.5	90.6	86.7	88.5	90.0	94.2	90.0	92.1	88.4	89.2	88.0	86.1	85.9	89.7	85.8
1926	94.8	94.7	95.6	94.7	95.0	96.7	91.3	93.4	91.2	96.6	95.4	98.9	95.2	95.3	95.3	94.9	92.4	98.7	93.5
1927	98.1	97.9	97.3	97.0	98.1	101.0	95.1	96.4	97.4	100.5	98.6	101.1	97.2	98.2	98.0	96.1	99.0	99.1	95.7
1928	98.7	98.7	98.3	97.8	98.4	100.0	96.0	100.4	98.5	100.8	100.2	101.2	99.2	96.3	99.4	97.3	99.2	99.5	95.8
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1930	104.2	104.1	105.1	102.4	104.0	106.6	101.8	107.7	104.6	104.3	105.6	105.0	103.9	104.6	104.9	101.5	105.5	105.5	103.8
1931	104.5	104.5	104.5	102.2	104.2	107.0	103.2	107.7	105.3	103.7	106.1	104.7	105.1	106.2	105.5	102.0	106.5	103.9	103.5
1932	89.3	89.3	89.2	87.5	85.4	93.4	98.5	100.7	88.2	93.1	89.6	87.1	91.4	92.1	90.9	90.5	92.3	89.4	85.8
1933	86.8	86.9	85.2	85.2	85.2	91.2	89.9	99.6	88.0	89.7	87.8	83.7	90.6	89.4	88.2	84.5	91.3	84.2	84.7
1934	87.4	87.4	87.7	84.5	86.7	92.1	90.1	101.4	93.2	92.1	86.4	84.6	91.4	89.7	89.2	84.4	92.5	87.3	90.3
1935	88.4	88.4	88.2	84.2	87.8	92.6	94.4	103.1	94.1	93.1	86.7	85.6	92.8	90.4	90.7	84.2	93.2	88.6	87.4
1936	91.6	91.4	93.4	84.7	92.3	95.0	96.9	104.2	95.5	95.5	91.1	86.1	95.2	92.2	93.7	85.2	95.6	96.2	92.1
1937	98.0	97.6	101.5	90.6	98.3	101.9	101.1	112.6	104.6	101.8	97.7	94.9	100.4	98.9	98.8	94.1	104.4	105.3	99.1
1938	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

INDEX OF WEEKLY HOURS IN UNION BUILDING TRADES (1929 = 100)

Industrial Relations Division
U. S. Department of Labor, Bureau of Labor Statistics

Year	All Building Trades	Journeymen	Helpers & Laborers	Bricklayers	Carpenters	Cement Finishers	Electricians (Inside Wiring)	Engineers (Portable & Hoisting)	Glaziers	Lathers	Painters	Plasterers	Plumbers & Gas Fitters	Sheet-Metal Workers	Steam & Sprinkler Fitters	Stonemasons	Structural Ironworkers	Building Laborers	Hod Carriers
1907	110.0	109.3	113.1	112.0	107.2	109.1	110.3	.....	.....	.....	114.1	108.8	104.7	105.4	105.9	106.8	108.1	108.5	110.5
1908	108.3	107.7	110.8	109.6	105.6	108.1	109.5	.....	.....	.....	112.3	108.3	104.8	105.3	105.9	106.8	105.9	108.5	110.5
1909	106.8	106.4	108.5	107.3	104.4	108.9	108.8	.....	.....	.....	110.7	108.3	104.8	105.3	105.6	106.8	104.5	108.1	110.1
1910	105.5	105.2	106.6	105.3	103.1	108.7	108.2	.....	.....	.....	109.3	108.2	104.6	105.3	105.0	105.2	103.4	105.5	109.2
1911	105.1	104.8	106.4	104.9	102.6	107.7	108.0	.....	.....	.....	108.6	108.8	104.3	105.0	104.9	104.5	103.2	105.5	108.6
1912	104.8	104.5	106.1	104.9	102.5	107.7	107.6	105.6	.....	104.0	108.5	107.5	103.5	103.7	104.2	104.5	102.1	105.5	107.8
1913	104.6	104.2	106.0	104.7	102.4	106.5	107.2	104.1	.....	104.0	107.9	107.5	103.5	103.5	103.8	104.4	101.7	105.5	107.8
1914	104.2	103.9	105.5	104.2	102.0	105.8	106.8	104.0	.....	104.0	107.6	107.4	103.1	103.4	102.5	104.4	101.5	105.2	106.4
1915	104.1	103.8	105.4	104.1	102.0	105.8	106.2	103.5	.....	103.5	107.6	106.9	103.1	103.2	102.5	104.3	101.5	105.2	106.4
1916	103.7	103.4	105.1	103.9	102.0	104.2	105.3	103.1	.....	103.5	106.9	105.8	102.6	102.8	102.2	104.1	101.2	104.6	106.4
1917	103.5	103.2	104.7	103.6	102.0	103.0	104.9	102.4	.....	103.0	106.8	105.7	102.5	102.7	102.1	104.0	101.0	103.5	106.3
1918	102.9	102.6	104.3	103.6	100.9	102.5	104.2	100.8	101.6	103.0	106.3	105.4	101.6	101.6	101.1	104.0	100.7	103.0	106.3
1919	102.4	102.2	103.3	103.4	100.3	101.7	103.3	100.3	101.6	102.7	106.1	105.4	101.3	101.2	101.0	103.4	100.5	101.1	105.9
1920	101.9	101.7	102.7	103.3	100.4	101.2	103.0	99.8	101.2	102.1	103.0	105.2	101.3	100.8	100.9	103.4	100.5	100.0	105.7
1921	101.8	101.6	102.7	103.3	100.3	101.2	103.0	99.4	101.6	101.9	103.1	104.9	101.1	100.8	100.8	103.5	100.5	100.0	105.7
1922	101.8	101.7	102.4	103.3	100.4	101.1	103.0	99.1	101.7	102.0	103.9	105.0	101.1	100.7	100.8	103.4	100.5	99.3	105.9
1923	101.9	101.8	102.6	103.3	100.7	101.1	103.0	98.7	101.2	102.3	103.6	105.5	101.1	100.7	100.8	103.4	100.5	100.0	105.9
1924	101.9	101.8	102.6	103.2	100.6	101.1	102.9	98.7	101.2	102.1	103.5	105.6	101.1	100.7	100.8	103.1	100.5	97.7	105.8
1925	101.9	101.8	102.4	103.1	100.6	100.8	102.9	99.0	100.8	101.8	103.8	105.3	101.1	100.7	100.8	103.1	100.2	99.8	105.7
1926	101.7	101.6	102.2	103.2	100.6	100.8	102.9	99.2	101.2	101.5	103.4	102.2	101.1	100.7	100.7	103.3	100.5	100.0	105.8
1927	101.5	101.4	102.2	102.7	100.6	100.5	102.9	100.8	101.5	101.0	103.0	101.8	100.9	100.4	100.5	103.1	100.5	100.2	105.8
1928	100.9	100.7	102.1	102.7	100.0	99.9	102.4	99.7	101.1	100.5	100.3	100.9	100.9	100.1	100.5	103.0	100.4	100.1	105.8
1929	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1930	97.2	97.1	97.8	97.6	96.9	96.1	97.6	95.1	96.8	94.3	98.9	97.7	95.4	96.3	95.5	96.6	96.9	98.1	99.3
1931	96.0	95.8	97.0	96.1	95.4	95.0	96.6	93.7	95.1	93.8	98.0	97.0	94.1	94.7	94.5	94.9	95.8	97.0	98.8
1932	94.3	94.1	94.8	93.9	93.0	93.9	94.3	92.6	92.9	93.3	97.9	95.2	93.7	93.3	93.6	94.5	93.4	93.6	96.6
1933	94.0	93.8	94.4	94.9	91.6	95.7	94.3	91.7	92.9	92.9	97.7	97.2	93.3	93.2	93.1	93.8	93.1	93.2	96.1
1934	90.5	90.3	91.4	93.3	90.8	92.2	88.7	89.7	88.1	87.5	85.6	93.1	92.4	91.9	92.5	93.4	91.8	89.1	94.3
1935	89.8	89.7	90.8	93.2	90.4	92.0	85.1	89.2	87.5	87.4	85.5	91.6	91.8	92.0	92.2	93.3	90.7	89.0	94.2
1936	89.8	89.6	91.0	93.2	90.5	91.6	85.4	89.7	87.8	86.5	85.9	90.1	90.6	91.9	92.4	93.3	90.6	89.5	94.0
1937	90.2	90.0	91.3	94.1	90.3	91.7	89.6	89.5	87.9	87.7	85.9	90.2	91.1	92.0	92.5	93.3	90.2	89.7	94.3
1938	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Building Trades Wage Rates Prevailing Feb. 1, 1939

Compiled by Public Works Administration from its records

	Mosaic and Terrazzo	Tile Layers	Stone Cutters	Stone Masons	Cement Finishers	Bricklayers	Masons' Helpers	Plasterers	Lathers	Building Labor	Carpenters	Electrical Workers	Elevator Constructors	Hoist Eng. 1 Drum	Hoist Eng. 2 Drum	Shovel Operators	Structural Ironworkers	Reamers	Painters	Glaziers	Plumbers	Steam Fitters	Sheet Metal Workers	Roofers	Water-proofers	Truck Drivers
Aberdeen, S. D.	1 20	1 37		1 37		1 20			1 00			1 00	1 10										1 00			
Albuquerque, N. M.	1 12	1 12		1 50	1 12	1 50	.75	1 50	1 25	.40	1 25	1 25	1 12	1 00	1 00	1 25	1 00	1 25	1 00		1 25	1 25	1 00	1 25	1 00	50
Atlanta, Ga.	1 25	1 25	1 00	1 25	1 25	1 25	.50	1 25	1 25	.40	1 00	1 25	1 15	1 00	1 00	1 25	1 37	1 12	1 00	.80	1 25	1 25	1 00	1 25	1 00	56
Atlantic City, N. J.							.85		1 25	.62	1 25	1 50	1 53	2 00	2 00	2 00	1 75	1 25	1 00	1 00	1 25	1 25	1 37	1 25	1 00	60
Baltimore, Md.	1 37	1 25	1 00	1 50	1 25	1 50	.75	1 25	1 37	.50	1 25	1 37	1 40	1 50	1 80	1 80	1 50		1 12	1 10	1 25	1 25	1 37			
Baton Rouge, La.	1 50	1 50		1 50	.80	1 50		1 25	1 50		.80	1 25	1 11						.80		1 25	1 25	.90			
Birmingham, Ala.	1 50	1 25	1 50	1 50	1 50	1 50	.40	1 50	1 25	.40	1 12	1 25	1 35	1 12	1 25	2 25	1 37	1 15	1 07	1 28	1 50	1 50	1 12	1 12	1 12	1 25
Boston, Mass.		1 50	1 35	1 50	1 45	1 50	.85	1 67	1 67	.85	1 37	1 50	1 52	1 37	1 37	2 40	1 40	1 50	1 25	1 37	1 50	1 50	1 37	1 37	1 37	75
Buffalo, N. Y.	1 25	1 25	1 25	1 50	1 25	1 50	.75	1 50	1 50	.65	1 30	1 37	1 43	1 33	1 33	1 50	1 50	1 50	1 35	1 37	1 37	1 37	1 30	1 50	1 25	65
Butte, Mont.		1 10	1 37		2 00		1 33	2 00	1 67	.80	1 50	1 83	1 54	1 25	1 37	1 50	1 50	1 50	1 37	1 37	2 00	2 00	1 50	1 33		1 07
Camden, N. J.	1 37	1 50	1 62	1 25	1 25	1 62	1 07	1 62	1 50	.60	1 37	1 50	1 53	2 00	2 25	2 00	1 65	1 65	1 00	.85	1 50	1 50	1 00	1 00	1 00	90
Charleston, S. C.	1 25	1 25	1 00	1 25	1 00	1 25	.50	1 37	1 25	.40	1 00	1 00	1 25	1 00	1 25	1 40	1 37	1 37	1 00	85	1 25	1 25	1 00	1 00	1 00	75
Charleston, W. Va.	1 25	1 25	1 50	1 50	1 10	1 50	.62	1 37	1 25	.50	1 12	1 25	1 30	1 37	1 37	1 37	1 25	1 00	1 12	1 12	1 25	1 25	1 00	1 12	1 12	65
Charlotte, N. C.		1 25		1 25	1 00	1 25	.60	1 00	1 25	.30	.87	1 00		1 05	1 25	1 40	1 25	1 00	75		1 25	1 25	1 00	1 25	1 00	1 00
Cheyenne, Wyo.	1 37	1 37		1 37	1 00	1 37	.90	1 50	1 50	.55	1 12	1 20	1 22	1 25	1 37	1 50	1 12	1 00	1 12	1 12	1 20	1 20	1 20	1 00	1 50	.62
Chicago, Ill.	1 62	1 62	1 20		1 62	1 70	1 02	1 70	1 70	1 02	1 62	1 70	1 70	1 70	1 70	2 00	1 70	1 70	1 67	1 94	1 70	1 70	1 70	1 75		
Cincinnati, O.	1 25	1 37	1 62	1 62	1 37	1 62	1 00	1 62	1 40	.75	1 45	1 50	1 54	1 37	1 37	1 52	1 37	1 35	1 55	1 50	1 50	1 50	1 37	1 62		
Cleveland, O.	1 37	1 50	1 45	1 62	1 37	1 62	.90	1 62	1 62	.90	1 37	1 65	1 60	1 37	1 37	1 50	1 37	1 30	1 50	1 50	1 12	1 12	1 50	1 40	1 25	80
Columbia, S. C.	1 00	1 00	1 00	1 00	75	1 00	.40	1 00	1 12	.30	.87	1 00		1 00	1 25	1 50	1 25	1 00	1 00	1 00	1 00	1 00	90	.90	.75	50
Dallas, Tex.			1 25	1 50	1 20	1 50	.62	1 50	1 50	.50	1 00	1 25	1 42	1 00	1 25	1 50	1 25	1 00	1 00	75	1 00	1 00	1 00			
Davenport, Ia.	1 25	1 25	1 50	1 50	1 20	1 50	.65	1 50	1 50	.65	1 20	1 30	1 40	1 25	1 50	1 50	1 30	1 30	1 30	1 15	1 15	1 15	1 43	1 43	1 35	.70
Denver, Colo.	1 43	1 50	1 25	1 50	1 43	1 50	1 00	1 50	1 50	.71	1 43	1 43	1 46	1 43	1 43	1 50	1 37	1 43	1 43	1 25	1 20	1 20	1 37	1 37		1 00
Des Moines, Ia.		90	1 60	1 60	1 25	1 60	.72	1 37	1 43	.72	1 22	1 37	1 40	1 30	1 37	1 50	1 50	1 37	1 37	1 37	1 20	1 00	1 50	1 50	1 25	74
Detroit, Mich.	1 25	1 50	1 50	1 50	1 25	1 50		1 55	1 50	.70	1 25	1 65	1 55	1 50	1 50	1 50	1 50	1 50	1 25	1 25	1 10	1 85	1 25	1 10	1 00	85
Duluth, Minn.	1 25	1 25	1 00	1 25	1 00	1 25	.60	1 35	1 35	.62	1 12	1 12	1 00			1 50	1 50	1 50	1 25	1 25	1 25	1 25	1 25	1 25	1 25	85
Evansville, Ind.	1 50	1 25	1 50	1 50	1 25	1 50	.65	1 50	1 25	.50	1 25	1 25	1 25	1 25	1 25	1 25	1 25	1 25	1 25	1 00	1 00	1 00	1 00	1 00	1 00	60
Fargo, N. D.				1 35		1 35		1 35	1 25		1 00	87		1 00	1 25	1 50	1 00	.75	1 00	1 00	1 00	1 00				
Fort Smith, Ark.				1 25	1 00	1 25	.50	1 25	1 25	.50	1 00	1 20	1 25	1 37	1 50	1 50	1 15	1 15	1 25	1 25	1 00	1 25	1 00	1 00	1 00	60
Fort Wayne, Ind.				1 10	1 50	1 50		1 50	1 25	.60	1 12	1 25	1 35	1 50	1 50	1 50	1 50	1 25	1 25	1 25	1 00	1 00	1 12	1 12	.90	1 00	1 00	60
Grand Rapids, Mich.	1 25	1 25	1 50	1 50	1 25	1 50	.60	1 25	1 25	.50	1 00	1 25	1 35	1 50	1 50	1 50	1 25	1 25	1 25	1 50	1 37	1 37	1 37	1 37	1 25	1 25	1 15
Great Falls, Mont.	1 50	1 50	1 50	1 50	1 50	1 50	1 12	1 65	1 50	.90	1 50	1 37	1 25	1 50	1 50	1 50	1 37	1 25	1 25	.90	1 20	1 20	1 20	1 20	1 25	1 00	65
Green Bay, Wis.	1 25	1 25	1 25	1 25	1 25	1 25	.70	1 25	1 25	.65	1 00	1 00	1 25	1 10	1 25	1 50	1 50	1 50	1 25	85	1 12	1 12	1 00	1 00	1 00	
Harrisburg, Pa.	1 37	1 37	1 25	1 25	1 00	1 25	.85	1 25	1 37	.65	1 00	1 06	1 25	1 50	1 50	1 50	1 50	1 65	1 00	1 25	1 20	1 20	1 25	1 37	1 00	
Hartford, Conn.	1 25	1 25		1 25	1 25	1 25	.75	1 25	1 50	.60	1 12	1 12	1 50	1 30	1 50	1 50	1 37	1 12	1 12	1 25	1 50	1 50	1 25	1 37	1 00	45
Houston, Tex.	1 25	1 25	1 12	1 50	1 25	1 50	.50	1 50	1 50	.40		1 50	1 50	1 12	1 37	1 50	1 37	1 12	1 12	1 00	1 00	1 00	1 00	1 00	1 00	55
Huntington, W. Va.	1 25	1 25	1 50	1 50	1 25	1 50	.75	1 25	1 25	.50	1 00	1 12		1 37	1 37	1 37	1 37	1 37	1 30	1 25	1 50	1 50	1 32	1 32	.85	75
Indianapolis, Ind.	1 37	1 37	1 37	1 60	1 25	1 60	.95	1 37	1 45	.62	1 25	1 50	1 54	1 45	1 45	1 45	1 55	1 30	1 25	1 25	1 25	1 25	1 50	1 50	87	
Jackson, Miss.	1 50	1 50	1 50	1 50	1 25	1 50	.40	1 25	1 00	.40	1 00	1 00	1 34	1 25	1 50	1 50	1 25	1 00	.90	1 25	1 25	1 25	1 25	1 25	75	75
Jacksonville, Fla.	1 25	1 25	1 00	1 00	1 00	1 00	.50	1 00	1 00	.40	1 00	1 25	1 15	1 12	1 25	1 50	1 25	1 00	.75	1 00	1 25	1 25	1 25	1 25	1 25	75
Kansas City, Mo.	1 25	1 25	1 25	1 37	1 37	1 62	1 00	1 57	1 50	.85	1 37	1 37	1 52	1 37	1 50	1 50	1 50	1 50	1 37	.75	1 50	1 50	1 50	1 50	1 25	55
Knoxville, Tenn.		1 10				1 25	.60	1 25	1 00	.40	1 00	1 00	1 17	1 00	1 25	1 50	1 37	1 25	1 32	1 00	1 00	1 00	1 25	1 25	1 25	65
Lexington, Ky.	1 50	1 50	1 37	1 37	1 00	1 37	.70	1 25	1 25	.50	1 10	1 00	1 42	1 00	1 25	1 50	1 37	1 25	1 32	80	1 00	1 00	1 25	1 25	1 25	80
Lincoln, Nebr.	1 37	1 37	1 37	1 37	1 25	1 37	.80	1 25	1 25	.80	1 00	1 00	1 25	1 12	1 25	1 50	1 37	1 25	1 32	80	1 00	1 00	1 25	1 25	1 25	80
Los Angeles, Cal.	1 25	1 25	1 25	1 25	1 25	1 37	.75	1 50	1 50	.62	1 10	1 12	1 25	1 25	1 25	1 50	1 50	1 50	1 32	80	1 00	1 00	1 25	1 25	1 25	80
Louisville, Ky.	1 25	1 25	1 00	1 50	1 25	1 50	.87	1 50	1 37	.50	1 25	1 31	1 42	1 25	1 25	1 50	1 50	1 50	1 32	1 10	1 10	1 00	1 37	1 37	1 00	1 00
Manchester, N. H.				1 50	1 50	1 50	.80	1 50	1 37	.62	1 00	1 00		1 37	1 50	1 50	1 50	1 25	1 25	.90	1 25	1 25	1 00	1 00	1 00	70
Memphis, Tenn.	1 25	1 25	1 37	1 62	1 12	1 62	.62	1 56	1 37	.35	1 12	1 25	1 41	1 25	1 50	1 50	1 50	1 25	1 12	1 00	1 00	1 00	1 25	1 25	1 12	1 00
Miami, Fla.	1 62	1 62		1 62	1 50	1 50	.60	1 50	1 25	.50	1 12	1 50	1 50	1 25	1 50	1 50	1 62	1 25	1 25	1 12	1 00	1 00	1 37	1 37	1 25	1 25
Milwaukee, Wis.	1 30	1 37	1 45	1 45	1 30	1 45		1 37	1 37	.85	1 20	1 30	1 37	1 50	1 50	1 50	1 65	1 37	1 25	1 12	1 00	1 00	1 35	1 35	1 20	1 25
Minneapolis, Minn.	1 25	1 32	1 37	1 37	1 25	1 37	.95	1 50	1 50	.85	1 25	1 37	1 38	1 25	1 37	1 50	1 50	1 50	1 25	1 12	1 10	1 10	1 37	1 37	1 25	1 00
Mobile, Ala.	1 25	1 25	1 25	1 25	1 00	1 25		1 00	1 25		.90			1 25	1 25	1 25	1 25	1 25	1 00	1 00		.75	1 25	1 25		.75
Nashville, Tenn.	1 25	1 25		1 50	1 25	1 50	.50	1 37	1 25	.40	1 10	1 12	.75	1 50	1 50	1 50	1 25	1 25	1 00	1 00	1 25	.75	1 50	1 65	1 00	1 40
Newark, N. J.	1 53	1 69	1 69	1 81	1 81	1 81	.75	1 37	1 50	.50	1 00	1 37	1 37	1 00	1 25	1 40	1 37	1 00	1 25	.75	1 25	.75	1 12	1 12	1 25	1 25
New Haven, Conn.	1 37	1 37		1 37	1 37	1 37	.75	1 25	1 50	.50	1 00	1 37	1 37	1 00	1 25	1 40	1 37	1 00	1 25	.75	1 50	.75	1 50	1 65	1 25	1 25
New Orleans, La.	1 25	1 25	1 25	1 25	1 00	1 25		1 00	1 25		.90			1 25	1 25	1 25	1 25	1 25	1 00	1 00	1 25	.75	1 25	1 25	1 00	1 00
New York, N. Y.	1 75	1 69	1 93	1 89	1 75	1 89	1 14	2 00	1 75	1 03	1 75	2 00	1 75	2 00	2 25	2 12	1 92	1 75	1 50	1 89	2 00	2 00	1 75	1 86	1 75	1 25
Norfolk, Va.	1 37	1 37	1 37	1 37	1 10	1 37	.65	1 25	1 25	.50	.90	1 00	1 12	1 25	1 25	1 40	1 25	1 25	1 00	1 00	1 10	1 10	1 10	1 10	1 10	65
Ogden, Utah	1 12	1 12	1 25	1 25	1 12	1 37	.90	1 50	1 50	.65	1 12	1 25	1 35	1 25	1 25	1 25	1 25	1 25	1 25	1 00	1 20	1 20	1 25	1 25	1 20	75
Oklahoma City, Okla.	1 50	1 50	1 50	1 50	1 50	1 50	.70	1 50	1 50	.50	1 12	1 25	1 25	1 25	1 25	1 50	1 25	1 12	.90	1 00	1 25	1 25	1 00	1 00	1 00	80
Omaha, Nebr.	1 37	1 37	1 37	1 37	1 37	1 25	.50	1 37	1 37	.50	1 12	1 25	1 25	1 12	1 37	1 50	1 37	1 37	1 12	1 25	1 40	1 40	1 25	1 25	1 25	75
Peoria, Ill.	1 25	1 50		1 62	1 37	1 62	.82	1 62	1 50	.82	1 37	1 37	1 37	1 42	1 37	1 50	1 50	1 37	1 15	1 00	1 40	1 40	1 37	1 37	1 37	80
Philadelphia, Pa.	1 27	1 40	1 50	1 50	1 25	1 65	.70	1 56	1 50	.60	1 25	1 50	1 50	1 53	1 25	1 62	1 62	1 37	1 25	1 12	1 25	1 25	1 44	1 44	1 37	85
Phoenix, Ariz.	1 25	1 50	1 25	1 25	1 25	1 50	.75	1 50	1 25	.75	1 12	1 12	1 25	1 25	1 25	1 25	1 50	1 37	1 15	1 00	1 40	1 40	1 25	1 25	1 12	
Pittsburgh, Pa.	1 50	1 50	1 62	1 62	1 50	1 75	1 12	1 75	1 75	.80	1 50	1 50	1 65	1 50	1 56	1 56	1 50	1 50	1 37	1 12	1 12	1 28	1 50	1 62	1 50	1 50
Pocatello, Ida.				1 50	1 37	1 50		1 50	1 50	.75	1 12							1 25					1 29	1 12		
Portland, Me.	1 25	1 25					1 25	1 25	1 20	.50	.80	1 12		1 00	1 00	1 00	1 00	1 25	1 00	.75	1 25	1 25	1 50	1 50	1 25	1 25
Portland, Ore.		1 25	1 25	1 50	1 50	1 12	1 50	1 12	1 50	.75	.90	1 25	1 40	1 00	1 25	1 50	1 37	1 12	1 10	.85	1 00	1 00	1 35	1 37	1 00	1 00
Portsmouth, N. H.	1 50	1 50			1 25	1 50	.80	1 25	1 25	.62	1 00	1 10	1 41	1 00	1 37	1 62	1 37	1 25	1 00	1 00	1 00	1 00	1 00	1 00	1 00	1 00
Providence, R. I.	1 50	1 50	1 50	1 50	1 50	1 15	1 50	.70	1 50	1 50	1 00	1 00	1 00	1 00	1 37	1 75	1 50	1 50	1 25	1 10	1 50	1 50	1 50	1 50	1 15	1 15
Raleigh, N. C.	1 10	1 10		1 10			1 10																			
Reno, Nev.							1 75	1 17	1 75	1 50	.62	1 25	1 50	1 50	1 50	1 25	1 40	1 50	1 25	1 50	1 50	1 50	1 00	1 00		.90
Richmond, Va.	1 25	1 25	1 37	1 50	1 00	1 50	.50	1 25	1 25	.50	.90	1 00	1 25	1 00	1 25	1 50	1 50	1 50	1 50	1 20	1 50	1 50	1 25	1 25	1 25	65
Rochester, N. Y.	1 32	1 32	1 25	1 37	1 37	1 37	.65	1 37	1 50	.65	1 22	1 37	1 40	1 25	1 37	1 50	1 50	1 30	1 30	1 15	1 15	1 15	1 37	1 37	1 17	70
Rock Island, Ill.	1 25	1 25	1 50	1 50	1 20	1 50	.65	1 50	1 50	.65	1 20	1 30	1 39	1 50	1 50	1 50	1 50	1 50	1 25	1 19	1 10	1 10	1 50	1 50	1 31	1 19
Sacramento, Cal.	1 16	1 31		1 75	1 19	1 75	1 05	1 57	1 50	.75	1 19	1 37	1 50	1 31	1 31	1 50	1 50	1 50	1 25	1 25	80	80	1 20	1 20	90	80
Saginaw, Mich.	1 25	1 50					1 75	1 00	1 50	.65	1 00	1 00	1 38	1 50	1 50	1 50	1 50	1 50	1 25	1 00	1 00	1 00	1 20	1 20	1 18	90
Salt Lake City, Utah	1 12	1 12		1 50	1 50	1 50	.75	1 50	1 50	.50	1 00	1 00	1 28	1 25	1 25	1 25	1 25	1 25	1 12	1 00	1 00	1 00	1 20	1 20	1 18	90
San Antonio, Tex.	1 25	1 25	1 50	1 50	1 37	1 50	.50	1 50	1 50	.50	1 00	1 00	1 25	1 25	1 25	1 25	1 25	1 25	1 12	1 00	1 00	1 00	1 50	1 50	1 25	1 00
San Francisco, Cal.	1 00	1 37	1 12	1 25	1 75	1 25	1 25	1 67	1 67	.81	1 25	1 37	1 50	1 37	1 37	1 37	1 37	1 37	1 21	1 21	1 50	1 50	1 37	1 37	1 25	1 00
Savannah, Ga.	1 00	1 00	1 00	1 00	1 00	1 00	1 00	1 00	1 00	.30	.90	1 00	1 00	1 00	1 00	1 00	1 00	1 00	.75	1 20	1 25	1 25	1 37	1 35	1 25	1 00
Seattle, Wash.	1 35	1 35	1 60	1 60	1 25	1 60	1 15	1 60	1 50	.90	1 25	1 50	1 50	1 50	1 50	1 50	1 50	1 50	1 00	1 00	1 00	1 00	1 12	1 12	1 00	1 12
Sioux City, Ia.			1 50	1 50	1 12	1 50	.60	1 50	1 50	.80	1 12	1 25	1 25	1 25	1 25	1 50	1 62	1 50	1 30	1 25	1 25	1 25	1 40	1 40	1 25	1 15
Spokane, Wash.				1 67	1 62	1 67	.85	1 67	1 50	.80	1 00	1 25	1 40	1 46	1 35	1 50	1 65	1 30	1 25	1 12	1 12	1 12	1 37	1 37	1 25	75
Springfield, Ill.	1 62	1 50	1 62	1 62	1 62	1 62	1 00	1 62	1 50	.87	1 25	1 37	1 47	1 50	1 50	1 50	1 50	1 50	1 37	1 37	1 50	1 50	1 62	1 62	1 50	70
Springfield, Mass.	1 62	1 62	1 62	1 62	1 62	1 62	1 00	1 62	1 62	.87	1 50	1 50	1 58	1 50	2 00	2 00	1 75	1 75	1 37	1 28	1 62	1 62	1 37	1 37	1 25	75
St. Louis, Mo.	1 30	1 50	1 25	1 25	1 57	1 50	1 00	1 75	1 62	.87	1 50	1 50	1 58	1 50	2 00	2 00	1 50	1 37	1 37	1 10	1 50	1 50	1 25	1 25	1 25	68
St. Paul, Minn.	1 25	1 32	1 37	1 37	1 25	1 50	.67	1 50	1 50	.67	1 25	1 35	1 38	1 25	1 40	1 40	1 50	1 62	1 25	1 10	1 62	1 62	1 37	1 37	1 25	70
Syracuse, N. Y.	1 25	1 25	1 00	1 50	1 25	1 50	.80	1 62	1 62	.75	1 12	1 37	1 42	1 25	1 37	1 37	1 50	1 62	1 25	1 10	1 50	1 50	1 25	1 25	1 00	68
Toledo, Ohio	1 25	1 50	1 25	1 62	1 62	1 62	.62	1 62	1 25	.50	1 00	1 00	1 43	1 00	1 25	1 25	1 50	1 50	1 25	1 25	1 25	1 25	1 50	1 50	1 25	70
Topeka, Kan.		1 25		1 12	1 25	1 37		1 37	1 25	.50	1 25	1 37	1 35	1 25	1 25	1 25	1 50	2 00	1 50	1 57	1 50	1 50	1 65	1 50	1 50	68
Tulsa, Okla.	1 50	1 50	1 50	1 50	1 50	1 50	.70	1 50	1 50	.70	1 50	1 88	1 88	1 75	1 75	2 00	1 50	2 00	2 00	1 12	1 25	1 25	1 50	1 50	1 25	70
Washington, D. C.	1 50	1 50	1 50	1 50	1 75	1 37	.70	2 00	1 62	.70	1 25	1 50	1 36	1 25	1 25	1 37	1 50	1 37	1 37	1 12	2 00	2 00	1 50	1 65	1 50	80
Wheeling, W. Va.	1 50	1 37	1 50	1 50	1 50	1 50		1 25	1 50		1 25	1 25	1 36	1 25	1 25	1 37	1 37	1 10	1 10	1 25	1 12	1 25	1 25	1 50	1 25	80
Wichita, Kan.		87		87	1 25	1 25	.87	1 25	1 25		1 00	1 00	1 00					1 65	1 25	1 00	1 00	1 00	1 21	1 21	1 00	1 00
Wilmington, Del.	1 25	1 12	1 25	1 25	1 25	1 25	1 50	.50	1 37	1 25	1 25	.50	1 25	1 12	1 35	1 37	1 50									62

Yearly Average WAGES OF SIX BUILDING TRADES in Seven Cities

Bricklayers

	Boston	New York	Chicago	Birmingham	St. Louis	San Francisco	Seattle
1913	$0.65	$0.70	$0.75	$0.70	$0.70	$0.875	$0.75
1914	.65	.75	.75	.70	.75	.875	.75
1915	.65	.75	.75	.70	.75	.875	.75
1916	.65	.75	.75	.70	.75	.875	.75
1917	.70	.75	.75	.70	.75	.875	.81
1918	.80	.81	.75	.875	.85	1.00	1.00
1919	.80	.875	.875	.875	1.00	1.125	1.125
1920	1.00	1.25	1.25	1.00	1.25	1.25	1.25
1921	1.00	1.25	1.25	1.00	1.25	1.25	1.125
1922	1.00	1.25	1.10	1.00	1.25	1.25	1.125
1923	1.25	1.50	1.10	1.125	1.50	1.375	1.25
1924	1.25	1.50	1.35	1.125	1.75	1.25	1.25
1925	1.25	1.50	1.50	1.25	1.75	1.25	1.35
1926	1.35	1.645	1.56	1.25	1.75	1.25	1.375
1927	1.40	1.75	1.625	1.25	1.75	1.375	1.375
1928	1.42	1.75	1.625	1.45	1.75	1.375	1.4275
1929	1.50	1.84	1.65	1.50	1.75	1.375	1.50
1930	1.50	1.925	1.70	1.50	1.75	1.375	1.50
1931	1.50	1.7125	1.70	.8125	1.75	1.375	1.1875
1932	1.105	1.47	1.40	.825	1.50	1.175	.975
1933	1.10	1.575	1.406	.812	1.50	1.125	1.01
1934	1.12	1.53	1.50	1.00	1.50	1.50	1.30
1935	1.20	1.50	1.50	1.00	1.50	1.50	1.00
1936	1.28	1.50	1.50	1.00	1.50	1.50	1.00
1937	1.50	1.725	1.62	1.33	1.50	1.60	1.54
1938	1.50	1.886	1.70	1.50	1.50	1.75	1.60

Hodcarriers

	Boston	New York	Chicago	Birmingham	St. Louis	San Francisco	Seattle
1913	$0.35	$0.375	$0.40	.....	$0.4875	$0.50	.....
1914	.35	.375	.40	.....	.4875	.50	.....
1915	.35	.375	.40	.....	.4875	.50	.....
1916	.35	.375	.425	.....	.4875	.50	.....
1917	.40	.425	.45	.....	.4875	.50	.....
1918	.425	.47	.50	.....	.51	.625	.....
1919	.50	.575	.575	.....	.6375	.75	.....
1920	.70	.775	1.00	.....	.70	.93	.....
1921	.70	.875	1.00	.....	.85	1.00	$0.875
1922	.70	.875	.725	.....	.85	.71	.875
1923	.70	.95	.725	.....	1.00	.77	.93
1924	.82	1.00	.725	$0.385	1.20	.8125	.95
1925	.7625	1.00	.825	.6075	1.20	.8125	1.00
1926	.77	1.07	.88	.625	1.20	.8125	1.00
1927	.79	1.125	.925	.625	1.20	.875	1.00
1928	.805	1.125	.93125	.52	1.20	.875	1.00
1929	.85	1.15	.93	.50	1.20	.875	1.00
1930	.85	1.03⅛	.975	.50	1.20	.875	1.00
1931	.85	1.025	.975	.35	.875	.875	.70
1932	.70	1.00	.825	.40	1.00	.70	.80
1933	.70	.91	.....	.....	1.00	.70	.80
1934	.70	.825	.825	.....	.875	.70	1.00
1935	.70	.825	.825	.....	.875	.70	1.00
1936	.77	.825	.95	.30–.40	.875	1.00	1.00
1937	.85	1.14	1.025	.40	1.00	1.10	1.15
1938	.85	1.14	1.025	.40	1.00	1.25	1.15

Carpenters

1913	$0.50	$0.625	$0.65	$0.525	$0.625	$0.625	$0.56
1914	.55	.625	.65	.45	.625	.625	.56
1915	.55	.625	.65	.45	.625	.625	.56
1916	.57	.625	.70	.45	.625	.625	.56
1917	.60	.69	.70	.45	.65	.68	.65
1918	.65	.69	.70	.55	.70	.75	.825
1919	.75	.75	.80	.65	.825	.875	.93
1920	1.00	1.125	1.25	.75	1.00	1.06	1.00
1921	1.00	1.125	1.25	.75	1.25	1.125	.875
1922	1.00	1.125	1.10	.75	1.10	1.04	.875
1923	1.05	1.125	1.25	.75	1.25	1.04	1.00
1924	1.05	1.3125	1.17	.76	1.525	1.00	1.00
1925	1.0875	1.3125	1.3475	.6025	1.50	1.00	1.0825
1926	1.20	1.45	1.39	.6575	1.50	1.00	1.125
1927	1.25	1.50	1.30	.95	1.50	1.125	1.125
1928	1.279	1.50	1.50	1.00	1.50	1.125	1.125
1929	1.38	1.55	1.47	1.00	1.50	1.125	1.125
1930	1.375	1.65	1.625	1.00	1.50	1.125	1.125
1931	1.175	1.45	1.625	.60	1.50	1.125	.875
1932	1.04	1.33	1.40	.60	1.275	.96	.695
1933	1.065	1.375	1.3125	.60	1.25	.90	.73
1934	.9375	1.40	1.3125	1.00	1.25	1.05	.83
1935	.9275	1.40	1.3156	1.00	1.25	1.10	1.00
1936	.937	1.40	1.50	.88	1.25	1.12	1.00
1937	1.14	1.60	1.57	1.06	1.35	1.31	1.23
1938	1.343	1.75	1.625	1.125	1.25	1.25	1.25

Plasterers

1913	$0.65	$0.69	$0.75	.....	$0.75	$0.875	$0.75
1914	.65	.69	.75	.....	.75	.875	.75
1915	.65	.69	.75	.....	.75	.875	.75
1916	.70	.75	.75	.....	.75	.875	.75
1917	.70	.75	.75	.....	.75	.875	.875
1918	.70	.75	.81	.....	.875	1.00	1.00
1919	.80	.90	.875	.....	1.00	1.125	1.125
1920	1.00	1.25	1.25	.....	1.25	1.25	1.25
1921	1.25	1.25	1.25	.....	1.375	1.375	1.25
1922	1.125	1.25	1.10	.....	1.375	1.275	1.125
1923	1.125	1.25	1.50	.....	1.50	1.275	1.25
1924	1.25	1.50	1.50	.....	1.75	1.275	1.375
1925	1.25	1.50	1.50	.....	1.75	1.50	1.375
1926	1.50	1.75	1.50	.....	1.75	1.50	1.375
1927	1.50	1.75	1.625	.....	1.75	1.50	1.375
1928	1.50	1.75	1.625	.....	1.75	1.50	1.50
1929	1.50	1.75	1.625	.....	1.75	1.375	1.50
1930	1.625	1.925	1.70	.....	1.75	1.375	1.50
1931	1.50	1.7125	1.70	$1.00	1.75	1.375	1.1875
1932	1.625	1.50	1.375	1.25	1.50	1.10	1.20
1933	1.375	1.50	1.375	.....	1.50	1.10	1.20
1934	1.231	1.50	1.50	1.00	1.50	1.38	1.18
1935	1.375	1.50	1.50	1.00	1.50	1.25	1.375
1936	1.375	1.50	1.50	1.00	1.50	1.35	1.25
1937	1.625	1.80	1.62	1.00	1.51	1.51	1.54
1938	1.625	2.00	1.70	1.00	1.58	1.65	1.60

Structural Ironworkers

1913	$0.625	$0.625	$0.68	$0.625	$0.65	$0.75	$0.625
1914	.625	.625	.68	.625	.65	.75	.625
1915	.625	.625	.68	.625	.65	.75	.625
1916	.625	.66	.68	.625	.675	.75	.625
1917	.68	.68	.69	.625	.70	.75	.75
1918	.80	.80	.70	.75	.80	.875	.875
1919	.80	.875	.875	.80	.925	1.00	1.00
1920	1.00	1.125	1.25	1.00	1.25	1.125	1.125
1921	1.00	1.125	1.25	.....	1.25	1.25	1.125
1922	1.00	1.125	1.05	.....	1.06	1.125	1.00
1923	1.05	1.125	1.05	1.05	1.25	1.125	1.125
1924	1.16	1.29	1.25	1.00	1.45	1.125	1.125
1925	1.1375	1.4675	1.36	1.135	1.50	1.125	1.125
1926	1.23	1.60	1.405	1.25	1.50	1.125	1.125
1927	1.25	1.75	1.50	1.55	1.50	1.375	1.155
1928	1.3125	1.75	1.50	1.75	1.50	1.375	1.215
1929	1.375	1.81	1.57	1.63	1.57	1.375	1.25
1930	1.375	1.925	1.625	1.25	1.75	1.375	1.25
1931	1.375	1.925	1.625	.75	1.75	1.375	1.1875
1932	1.205	1.675	1.375	.75	1.50	1.13	1.13
1933	1.14	1.65	1.35	.75	1.47	1.20	1.10
1934	1.20	1.62	1.35	1.00	1.47	1.375	1.13
1935	1.20	1.65	1.35	1.125	1.47	1.375	1.23
1936	1.20	1.58	1.50	1.10	1.47	1.375	1.25
1937	1.375	1.79	1.58	1.25	1.73	1.44	1.39
1938	1.479	1.925	1.70	1.25	1.75	1.50	1.50

Common Laborers

1913	$0.35	$0.225	$0.40	.....	$0.25	$0 27	$0.375
1914	.35	.225	.40	.....	.25	.31	.375
1915	.35	.25	.40	.....	.25	.31	.375
1916	.35	.25	.425	.....	.25	.31	.375
1917	.375	.30	.45	.....	.30	375	.4375
1918	.40	.405	.50	.....	.365	.43	.56
1919	.40	.405	.575	.....	.425	.625	.6875
1920	.6875	.75	1.00	.....	.6075	.75	.75
1921	.6875	.60	1.00	.....	.6075	.81	.75
1922	.6875	.60	.725	.....	.5575	.625	.625
1923	.6875	.615	.725	.....	.6075	.625	.625
1924	.6625	.6875	.8175	$0.335	.70	.525	.625
1925	.6025	.6525	.8175	.31	.6525	.525	.5625
1926	.615	.815	.86	.30	.6525	.525	.5675
1927	.595	.90625	.8875	.325	.5875	.55	.64
1928	.6025	.90625	.90	.325	.60	.55	.678
1929	.625	.985	.92	.29	.61	.57	.70
1930	.625	1.03125	.975	.275	.6375	.6875	.70
1931	.60	.65625	.7375	.20	.6125	.59⅜	.60
1932	.575	.645	.665	.225	.56	.56	.485
1933	.548	.725	.784	.248	.6223	.64	.48
1934	.55	.8475	.825	.30	.7875	.64	.53
1935	.575	.68	.825	.30	.7875	.625	.60
1936	.581	.65	.95	.35	.7875	.651	.60
1937	.725	.91	.99	.35	.86	.75	.87
1938	.735	.912	1.025	.35	.663	.65	1.00

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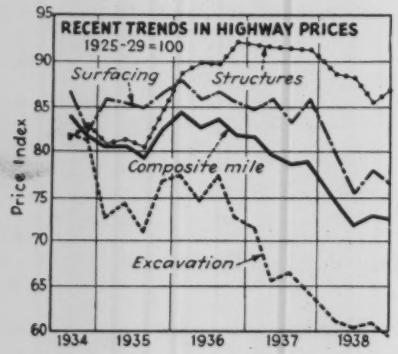
Highway Construction Cost Trends

AFTER a rather sharp drop in the first half of 1938, highway costs levelled off or even recovered slightly, according to the index of average bid prices on federal aid projects prepared by the construction division of the U. S. Bureau of Public Roads. The index is based on average prices for the 1925-1929 period for a so-called composite mile of road in which "composite" are included excavation, surfacing and structures. For comparative purposes quantities are considered constant although, in actual practice, quantities are constantly increasing. The base quantities and prices are given at the head of the accompanying table.

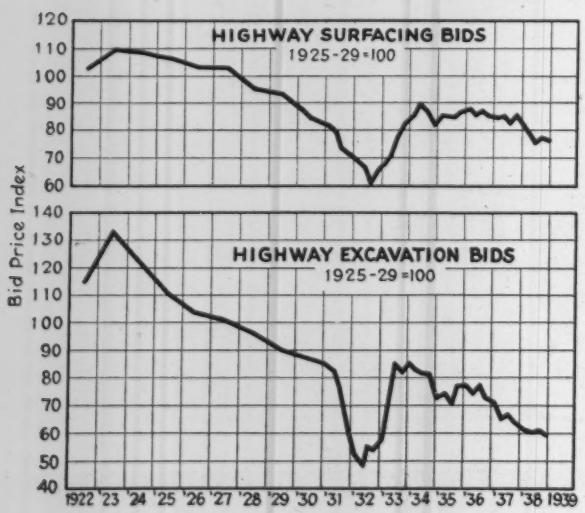
The trend in all components has been downward since 1936, with excavation showing the sharpest drop, a result, it is believed, of the influence of larger and faster earth-moving equipment. A somewhat longer view of trends reveals that while excavation and surfacing costs have declined since 1933, highway structure costs have risen. Examination of the figures shows, however, that the rise from the depression low in 1932 has been about the same for all three components; whereas excavation and surfacing costs jumped 50 per cent from 1932 to 1934, it took structure costs until 1937 to achieve the same rise.

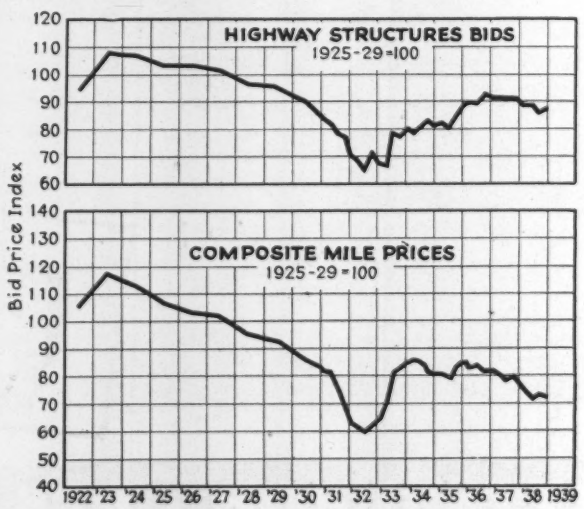


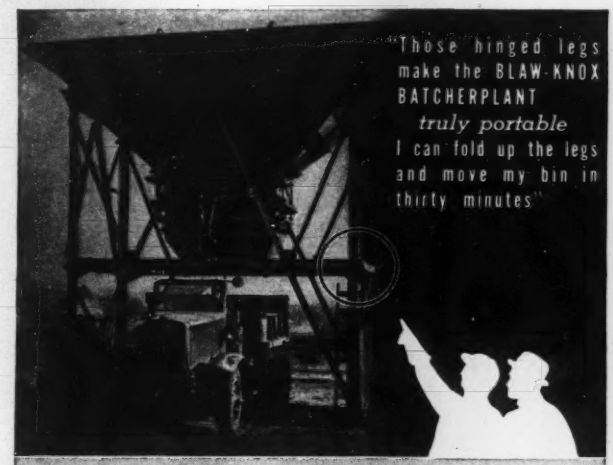
PRICE TREND IN HIGHWAY CONSTRUCTION FOR COMPOSITE STANDARD MILE

Year	Excavation [1] (17,491* cubic yards)		Surfacing [2] (3,726* square yards)		Structures				Composite mile
					Reinforcing steel (16,000* pounds)	Structural steel (4,325* pounds)	Structural concrete (68* cubic yards)	Combined	
	Bid price [3]	Sub-index	Bid price [3]	Sub-index	Bid price [3]	Bid price [3]	Bid price [3]	Sub-index	Index
Base period, 1925 to 1929	$0.35†	100.0	$2.22†	100.0	$0.052†	$0.067†	$22.15†	100.0	100.0
1922	.40	114.5	2.28	102.7	.050	.074	20.18	95.1	105.8
1923	.47	133.3	2.43	109.5	.057	.078	23.37	108.6	117.9
1924	.43	122.2	2.40	108.3	.057	.077	22.91	107.2	113.1
1925	.39	110.0	2.36	106.4	.056	.067	22.53	103.9	107.3
1926	.36	103.7	2.29	103.1	.053	.074	22.76	103.7	103.4
1927	.35	100.3	2.29	103.3	.051	.071	22.65	101.5	101.9
1928	.34	96.0	2.10	94.5	.049	.067	21.22	96.1	95.3
1929	.32	90.0	2.05	92.7	.048	.059	21.58	95.0	92.1
1930	.30	86.3	1.86	84.1	.045	.061	20.08	89.4	85.7
1931	.27	77.2	1.68	75.6	.040	.054	18.02	79.9	76.8
1932	.18	52.3	1.45	65.2	.034	.046	15.32	68.0	61.0
1933									
1st Q.	.20	57.0	1.49	67.2	.032	.043	15.44	66.4	63.4
2nd Q.	.25	70.7	1.58	71.3	.035	.043	14.67	66.2	70.3
3rd Q.	.30	84.6	1.74	78.6	.041	.049	17.36	78.1	80.7
4th Q.	.29	82.3	1.85	83.5	.042	.049	17.12	77.9	82.2
1934									
1st Q.	.30	85.5	1.90	85.7	.042	.049	17.82	79.9	84.7
2nd Q.	.29	82.6	1.98	89.3	.042	.051	17.31	79.1	85.3
3rd Q.	.29	81.7	1.92	86.7	.042	.053	17.98	81.3	84.0
4th Q.	.29	81.3	1.82	82.1	.044	.057	17.81	82.7	81.9
1935									
1st Q.	.25	72.7	1.90	85.8	.044	.051	17.62	80.7	80.3
2nd Q.	.26	74.1	1.89	85.1	.044	.052	17.51	81.1	80.5
3rd Q.	.25	70.9	1.88	84.8	.044	.052	17.22	80.2	79.1
4th Q.	.27	76.9	1.91	86.2	.044	.053	18.77	84.1	82.5
1936									
1st Q.	.27	77.2	1.94	87.7	.044	0.56	20.20	88.7	84.1
2nd Q.	.26	74.4	1.90	85.8	.046	0.59	20.06	89.7	82.3
3rd Q.	.27	77.2	1.91	86.3	.046	0.61	19.87	89.5	83.5
4th Q.	.25	72.7	1.89	85.3	.046	0.62	20.87	92.0	81.8
1937									
1st Q.	.25	71.2	1.88	84.8	.047	.063	20.31	91.7	81.0
2nd Q.	.23	65.5	1.90	85.8	.049	.067	19.42	91.3	79.3
3rd Q.	.23	66.1	1.85	84.4	.049	.067	19.42	91.5	78.4
4th Q.	.22	63.8	1.91	85.9	.048	.065	19.90	91.3	78.8
1938									
1st Q.	.21	61.0	1.77	79.8	.045	.065	19.13	88.6	74.4
2nd Q.	.21	60.1	1.67	75.2	.045	.061	19.10	88.2	71.8
3rd Q.	.21	60.7	1.73	77.8	.044	.061	18.73	85.4	72.8
4th Q.	.21	59.8	1.70	76.7	.044	.060	19.29	86.7	72.2

[1] Common excavation plus other excavation items expressed as equivalent common excavation.
[2] Portland-cement concrete plus other surfacing items expressed as equivalent portland-cement concrete.
[3] Indexes and totals were calculated with the bid prices carried to 1 more decimal place than that to which they are shown in this table.
Column showing amount of bid price times fixed quantity omitted in this table.
* Fixed quantities used for establishing composite mile for price trend.
† Fixed prices used for establishing composite mile index base.







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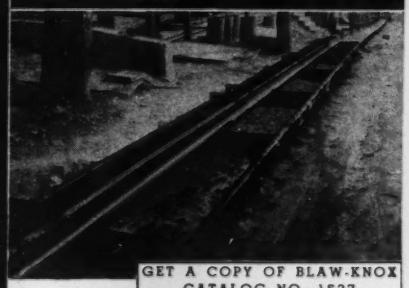

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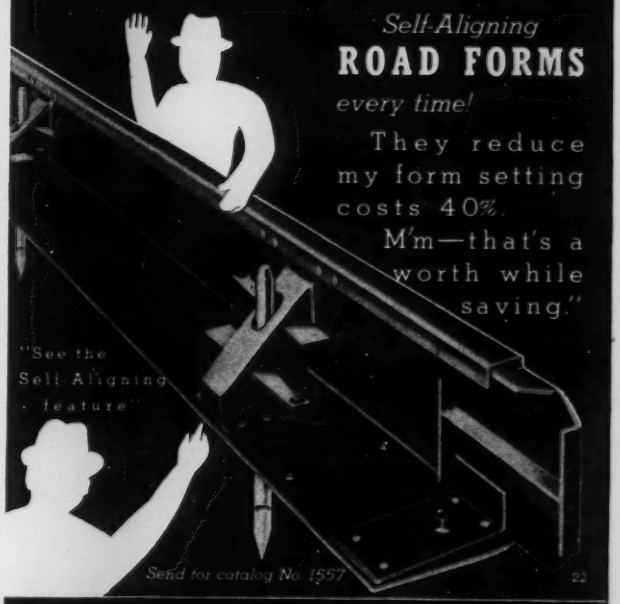
They reduce my form setting costs 40%. M'm—that's a worth while saving."



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BLAW-KNOX BLAW-KNOX DIVISION OF BLAW-KNOX CO. Farmers Bank Bldg. Pittsburgh, Pa.

Self Aligning ROAD FORMS

BASE RATES ON COMPENSATION INSURANCE FOR CONSTRUCTION—APRIL 1, 1938[5]

Data Compiled by Herbert L. Jamison & Co., Insurance Brokers, New York, N. Y.

Classification of work	Ala.	Ariz.	Ark.	Cal.	Colo.	Conn.	Del.	D. C.	Fla.	Ga. (E)	Idaho	Ill.	Ind.	Iowa	Kans.	Ky.	La.	Me.	Md.	Mass.	Mich.	Minn.	Miss.	Mo.
1 Wrecking Buildings or Demolition	17.83	35.22	Workmen's Compensation Act effective 6/8/39 — no rates available.	23.99	29.40	23.39	13.00	29.59	22.72	24.39	32.24	24.94	19.95	17.89	24.95	23.05	29.21	26.90	26.02	24.49	34.14	21.41	23.44	35.10
2 Blasting	G	G		G	G	4.64	2.75	G	3.72	4.28	6.68	4.89	3.94	3.54	4.62	3.90	5.90	5.00	4.56	6.95	4.80	6.13	5.24	10.22
3 Excavation, earth or common (1)	3.44	7.76		N. A.	6.04	D7.54	2.75	6.08	3.72	D7.31	7.81	5.93	5.35	D4.31	D6.03	D5.57	7.85	D6.50	D7.84	D9.22	D6.61	D7.30	9.93	D10.05
4 Excavation, rock (1)	D4.31	11.98		12.00	D7.17	8.27	4.00	D10.46	D5.55	8.70	11.54	6.04	8.62	6.96	7.60	8.57	12.39	10.36	8.34	16.19	10.59	9.90	15.87	16.77
5 Concrete Work, engineering structures (2)	6.87	14.26		11.12	10.11			13.40	8.04															
6 Concrete Work, bldgs. not over 3 stories	2.45	6.36		4.64	3.67	4.91	4.00	5.66	2.61	2.71	4.50	3.64	3.31	2.03	2.99	2.55	3.75	4.76	6.71	7.29	3.73	1.52	6.83	5.73
7 Concrete Work, bldgs. over 3 stories	4.27	8.43		5.60	5.69	6.43	4.00	6.57	4.86	4.50	7.38	6.46	3.87	3.86	6.50	5.77	7.61	6.46	7.46	7.17	6.99	7.30	9.71	8.87
8 Concrete Work, reinforced floors	4.27	8.43		5.60	5.69	6.43	4.00	6.57	4.86	4.50	7.38	6.46	3.87	3.86	6.50	5.77	7.61	6.46	7.46	7.17	6.99	7.30	9.71	8.87
9 Concrete Work, pavement	2.53	5.88		3.09	5.18	3.09	2.60	6.33	3.48	3.67	4.03	3.39	2.68	3.08	4.10	5.18	5.35	3.73	3.44	4.56	4.44	3.15	7.75	7.81
10 Carpentry, concrete form construction	3.92	9.16		6.42	6.56	4.96	2.00	6.39	4.14	7.27	7.47	7.18	5.87	3.32	5.25	5.00	7.86	7.26	6.76	9.43	5.80	5.15	11.50	5.97
11 Carpentry, bldgs. 3 stories or under	2.55	4.09		N.A.	4.53	2.78	2.00	4.14	N.A.	3.03	4.50	4.59	3.10	3.32	3.45	3.38	5.63	3.67	3.33	3.18	5.80	5.15	2.86	5.97
12 Carpentry, bldgs. over 3 stories	3.92	9.16		6.42	6.56	4.96	2.00	6.39	4.14	7.27	7.47	7.18	5.87	3.32	5.25	5.00	7.86	7.26	6.76	9.43	5.80	5.15	11.50	5.97
13 Carpentry, interior trim buildings	1.30	N.A.		N.A.	2.03	1.85	2.00	2.34	1.60	1.32	2.27	1.75	1.51	1.31	1.76	1.57	2.34	1.93	1.89	2.29	1.92	5.15	1.99	5.97
14 Structural Iron and Steel Erection	11.36	33.67		18.26	19.83	16.11	7.10	20.13	14.93	14.78	21.23	10.68	15.16	10.35	15.82	15.26	16.80	17.47	18.55	22.82	19.76	19.86	33.39	34.95
15 Ornamental Iron Erection	2.35	4.43		5.45	3.90	3.42	7.10	4.40	2.99	2.68	4.29	3.31	2.92	2.34	3.32	3.03	4.39	3.57	3.64	4.78	3.66	4.06	7.35	5.57
16 Roofing	5.39	N.A.		12.41	8.65	7.26	3.85	9.08	9.12	8.19	9.57	8.20	8.51	5.41	7.38	6.38	9.57	8.01	7.41	11.18	9.87	9.52	8.42	13.73
17 Waterproofing	2.53	5.63		4.34	4.02	3.63	N.A.	4.63	3.12	3.08	4.53	3.58	3.00	2.57	3.52	3.12	4.74	3.83	3.75	4.89	3.87	4.40	3.32	5.74
18 Lathing	1.68	4.06		5.97	2.70	2.41	1.10	3.07	2.10	2.47	3.00	2.35	2.03	1.69	2.33	2.08	3.12	2.53	2.54	3.29	2.55	2.89	2.46	3.84
19 Bricklaying	2.45	6.36		4.64	3.67	4.91	2.25	5.66	2.61	2.71	4.50	3.64	3.31	2.03	2.99	2.55	3.75	4.76	6.71	7.29	3.73	1.52	6.83	5.73
20 Sheet Metal Work	2.05	5.66		N.A.	3.34	2.91	1.40	3.27	2.62	2.82	3.67	2.73	3.05	2.07	2.81	2.63	3.66	3.07	3.09	2.54	3.62	3.14	6.25	4.17
21 Plumbing, heating, gas fitting	1.45	2.73		2.39	2.32	2.01	.95	2.66	2.13	1.74	2.53	1.82	2.17	1.56	1.94	1.80	2.88	2.08	2.27	2.22	2.05	2.86	2.94	3.03
22 Glazing	3.45	6.29		6.32	5.48	4.93	N.A.	6.25	4.30	4.39	6.09	4.35	4.11	3.47	4.71	4.22	6.19	5.12	5.01	3.62	5.13	5.77	3.71	7.30
23 Electrical Wiring, installing	1.26	2.68		2.61	2.00	1.74	.90	2.41	1.86	1.60	2.22	1.61	1.61	1.30	1.69	1.54	2.26	1.86	1.78	1.75	1.80	2.17	2.40	2.81
24 Electrical Equipment, installing	1.92	4.59		3.52	3.18	2.86	.90	3.44	3.08	2.63	3.38	3.10	2.31	1.97	3.46	2.34	3.77	2.82	2.66	4.13	3.17	3.47	5.09	5.34
25 Painting, struct. steel in field, eng. struct	11.36	33.67		18.26	19.83	16.11	7.10	20.13	14.93	14.78	21.23	10.68	15.16	10.35	15.82	15.26	16.80	17.47	18.55	22.82	19.76	19.86	33.39	34.95
26 Painting, buildings	2.32	4.54		5.62	4.15	3.17	1.75	4.55	3.11	3.00	4.63	3.34	3.74	3.60	3.50	3.15	4.65	3.40	3.77	N.A.	4.23	4.65	3.21	4.07
27 Watchmen and time keepers (4)	1.65	6.36		H	2.61	2.35	H	2.99x	2.07	2.31	2.92	2.23	1.96	1.64	2.25	2.03	2.93	2.45	2.44	3.17	2.44	2.74	5.41	3.66
28 Officers and Superintendents, supervising	.33	.88		.56	.57	.48	H	.64	.41	.54	.58	.43	.43	.30	.46	.43	.58	.48	.57	.69	.52	.54	.93	.77
29 Office workers	.07	.10		.08	.11	.09	.06	.11	.08	.07	.09	.07	.07	.07	.07	.07	.08	.08	.13	.07	.09	.08	.08	.07

Classification of work	Mont.	Neb.	Nev.[3]	N. H.	N. J.	N. M.	N. Y.	N. C.	N. D.[3]	Ohio[3]	Okla.	Ore.[3a]	Penn.	R. I.	S. C.	S. D.	Tenn.	Tex. (F)	Utah	Vt.	Va.	Wash.[5]	W. Va.[3]	Wisc.	Wyo.[3]
1 Wrecking Buildings or Demolition	35.71	36.94	State Insurance Plan.	18.97	30.20	20.42	N.A.	21.48	North Dakota State Plan: Workmen's Compensation Bureau, Bismarck, N. D.	Ohio State Plan: Workmen's Compensation, The Industrial Commission of Ohio, Actuarial Section, Columbus, Ohio.	47.40		40.00	33.82	32.77	19.30	21.27	27.12	44.96	16.23	18.40	24.93	West Virginia State Plan: State Compensation Commission, Charleston, W. Va.	30.00	Wyoming State Plan: Manager, Workmen's Compensation Dept., State Treasurer's Office, Cheyenne, Wyo.
2 Blasting	G	G		G	G	G	G	G			G		G	G	G	G	G	G	G	G	G	G		G	
3 Excavation, earth or common (1)	7.32	7.13		3.19	7.40	4.17	10.77	3.74			8.61		6.85	5.98	5.34	3.79	3.43	7.80	9.15	2.97	3.41	5.29		5.57	
4 Excavation, rock (1)	D8.75	8.99		D4.58	10.10	D4.97	D10.99	D6.79			D11.41		6.85	D8.31	D9.70	D4.70	D4.68	10.57	10.92	D3.95	D4.78	10.49		8.12	
5 Concrete Work, eng. structures (2)	12.80	15.82		6.75	10.80	7.23	14.76	8.28			24.25		10.50	11.97	12.48	6.92	8.01	14.32	16.16	5.80	8.56	N.P.		11.99	
6 Concrete Work, bldgs. not over 3 stories	4.95	4.15		3.50	7.10	2.85	R10.31	2.72			4.04		10.50	5.44	3.92	2.08	2.64	8.52	5.99	3.02	2.19	4.48		3.12	
7 Concrete Work, bldgs. over 3 stories	8.03	9.75		4.63	8.30	4.57	12.03	5.40			14.48		10.50	8.38	8.71	4.44	4.77	8.52	11.41	3.67	3.82	5.15		7.75	
8 Concrete Work, reinforced floors	8.03	9.75		4.63	8.30	4.57	12.03	5.40			14.48		10.50	8.38	8.71	4.44	4.77	8.52	11.41	3.67	3.82	5.15		7.75	
9 Concrete Work, pavement	4.45	4.41		2.48	7.30	2.70	6.39	5.40			7.82		9.35	4.40	4.57	2.92	3.77	7.46	4.00	2.25	3.68	3.01		6.74	
10 Carpentry, concrete form const.	8.15	7.31		4.34	6.50	4.71	9.53	5.47			14.74		4.80	8.58	7.91	4.42	5.05	8.52	9.40	3.92	4.24	6.08		6.32	
11 Carpentry, bldgs 3 stories or under	4.91	5.29		2.63	4.90	2.82	N.A.	2.78			6.29		4.80	4.34	4.65	2.71	2.64	4.93	6.37	2.24	2.47	4.59		6.32	
12 Carpentry, bldgs over 3 stories	8.15	7.31		4.34	6.50	4.71	9.53	4.19			14.74		4.80	8.58	7.91	4.42	5.05	8.52	9.40	3.92	4.24	6.08		6.32	
13 Carpentry, interior trim bldgs	2.43	2.55		1.35	A	1.40	N.A.	1.49			3.33		4.80	2.24	1.62	1.36	1.34	2.31	3.10	1.13	1.41	1.50		6.32	
14 Structural Iron and Steel Erection	24.23	24.95		12.52	22.70	13.95	48.43	14.71			33.42		21.00	23.98	19.63	12.65	11.89	33.27	30.17	10.85	12.72	19.52		18.11	
15 Ornamental Iron Erection	4.69	4.91		2.52	6.30	2.75	6.18	2.89			6.35		21.00	4.53	3.46	2.55	2.54	4.79	5.97	2.16	2.59	4.57		4.79	
16 Roofing	10.53	10.86		5.62	10.10	5.98	N.A.	6.71			13.94		11.25	9.79	9.15	5.73	5.68	13.87	13.25	4.81	5.49	N.P.		11.85	
17 Waterproofing	4.79	5.10		2.68	5.80	2.81	8.23	2.95			6.74		N.A.	4.51	3.80	2.71	2.69	5.43	6.22	2.24	2.75	N.P.		4.79	
18 Lathing	3.23	3.40		1.78	4.20	1.88	5.93	1.99			4.44		3.20	3.05	3.32	1.81	1.80	4.16	4.16	1.50	1.84	4.04		3.18	
19 Bricklaying	4.95	4.15		3.50	7.10	2.85	R10.31	2.72			4.04		6.95	5.44	3.92	2.08	2.64	8.52	5.99	3.02	2.19	4.48		3.12	
20 Sheet Metal Work	4.07	4.17		2.14	P4.50	2.30	7.91	2.56			5.32		4.05	3.78	3.59	2.20	2.30	4.72	5.12	1.83	2.31	4.59		3.68	
21 Plumbing, heating, gas fitting	2.75	2.89		1.47	3.10	1.54	4.51	1.80			3.85		3.00	2.54	2.31	1.52	1.65	2.93	3.46	1.32	1.50	2.24		2.53	
22 Glazing	6.63	6.87		3.58	6.60	3.77	14.03	4.01			8.90		N.A.	6.15	5.37	3.67	3.62	6.72	8.41	3.05	3.77	5.17		8.03	
23 Electrical Wiring, installing	2.44	2.49		1.29	2.30	1.37	3.54	1.65			3.18		2.20	2.24	2.14	1.34	1.34	2.66	3.06	1.12	1.41	2.53		2.29	
24 Electrical Equipment, installing	3.71	3.75		1.98	3.70	2.10	5.32	2.10			4.87		2.20	3.40	3.38	2.02	2.12	4.55	4.63	1.69	2.20	3.11		3.50	
25 Paint'g., struct. st'l. in f'ld, eng. str'ct.	24.23	24.95		12.52	22.70	13.95	A	14.71			33.42		21.00	23.98	19.63	12.65	11.89	33.27	30.17	10.85	12.72	19.52		18.11	
26 Painting, buildings	5.08	4.55		2.68	6.20	2.95	9.99	3.04			7.07		5.65	4.58	3.59	2.78	2.39	4.59	6.82	2.33	3.05	5.13		3.73	
27 Watchmen and time keepers (4)	3.20	3.31		1.71	A	1.80	7.10	1.94			4.22		H	2.99	2.85	1.76	1.73	H	4.02	1.44	1.82	4.69		3.03	
28 Officers and Supts., supervising	.70	.68		.35	.79	.40	.95	.42			.84		H	.70	.68	.34	.35	H	.84	.32	.38	N.P.		.66	
29 Office workers	.11	.08		.06	.09	.07	.10	.07			.08		.12	.09	.09	.09	.07	.10	.13	.07	.06	.07		.10	

Bold face type indicates Employers Liability Insurance as provided for in the states in question. (1) No caisson or compressed air work. (2) Bridges, culverts, retaining walls, dams, etc. (3) State Insurance Plan — no rates available. (3a) State Insurance Plan — non-hazardous classifications not subject to Monopolistic Compensation Act. (4) Governing classification applies when construction or erection work is being carried on. (5) Also has State Insurance Plan — non-hazardous classifications not subject to Monopolistic Compensation Act. (A) Rate must be assigned by Rating Board. (D) Supplementary rate will be charged for occupational disease hazard. (E) Rate revision effective 3/31/39 — not yet published. (F) Rate revision effective 4/1/39 — not yet published. (G) Payroll assigned to operation to which blasting is incidental. (H) Payroll assigned to governing class for job. (N.A.) Classification not available in the state. (N.P.) Rate not published. (P) Supplementary rate of $0.53 for lead burning. (R) Not applicable to concrete work in private residences. (S) Subject to increase or decrease according to experience ratings.

Small House Costs In 83 Cities

THE CUBIC-FOOT COST of building the same standard house in 83 representative U. S. cities is computed by the Federal Home Loan Bank Board. The cities reporting are divided into 3 groups or cycles, of which one cycle is given each month. Thus, the costs in each city are available four times a year.

In determining the cubic content of the house, length and width are taken as the actual measurement of the outside walls. Height is the distance from 6 inches below the finished surface of cellar floor to a point halfway between roof ridge and attic floor beams. Multiplying these factors gives the gross cube.

The house on which costs are reported is a detached 6-room home of 24,000-cu.ft. volume. Living room, dining room, kitchen and lavatory on first floor; 3 bedrooms and bath on second floor. Exterior is wide-board siding with brick and stucco as features of design. Best quality materials and workmanship are used.

The house is not completed ready for occupancy. It includes all fundamental structural elements, an attached 1-car garage, an unfinished cellar, an unfinished attic, a fireplace, essential heating, plumbing and electric wiring equipment, and complete insulation. It does not include wall-paper nor other wall or ceiling finish on interior plastered surface, lighting fixtures, refrigerators, water heaters, ranges, screens, weather stripping, nor window shades.

Reported costs include, in addition to material and labor costs, compensation insurance, an allowance for contractor's overhead and transportation of materials, plus 10 per cent for builder's profit.

Reported costs do not include the cost of land nor of surveying the land, the cost of planting the lot, nor of providing walks and driveways; they do not include architect's fee, cost of building permit, financing charges, nor sales costs.

In figuring costs, current prices on the same building materials list are obtained every three months from the same dealers, and current wages are obtained from the same reputable contractors and builders.

Small House Costs—Cents Per Cubic Foot

Federal Home Loan Bank Board

	1936				1937				1938				1939
	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.	Apr.	July	Oct.	Jan.
Albany, N. Y.	.217	.216	.221	.222	.233	.254	.254	.256	.258	....	.248	.244	.242
Atlantic City, N. J.	.244	.240	.239	.238	.256	.279	.257	.254	.247	....	.243	.242	.241
Boise, Idaho	.240	.238	.236	.238	.249	.258	.255	.257	.247	.247	.244	.250	.253
Buffalo, N. Y.	.229	.229	.238	.238	.243	.256	.269	.271	.261	.253	.256	.263	.255
Camden, N. J.	.213	.215	.215	.219	.230	.245	.245	.245	.238	.237	.244	.245	.233
Casper, Wyo.	....	....	.256	.237	.261	.266	....	.248	....	....	.249	.235	....
Des Moines, Iowa	.250	.251	.254	.256	.256	.266	.269	.269	.261	.256	.255	.257	.262
Detroit, Mich.	.214	.219	.221	.219	.229	.252	.264	.259	.254	.249	.256	.257	.258
Duluth, Minn.	....	.234	.236	.240	.237	.246	.265	.262	.260	.263	.262	.258	.249
Evansville, Ind.	....	.232	.233	.233	.230	.242	.242	....	.240	.240	....	.239	.244
Fargo, N. D.	.229	.229	.236	.233	.239	.249	.253	.249	.248	.247	.245	.243	.236
Grand Rapids, Mich.	....	.218	.213	.216	.219	.234	.241	.243	.246	.246	.246	.245	.246
Great Falls, Mont.	.269	.271	.276	.272	.274	.293	.293	.299	.292	.297	.296	....	.291
Indianapolis, Ind.	.239	.227	.229	.229	.229	.243	.244	....	.238	.245	.242	.240	.243
Kansas City, Mo.	.218	.221	.221	.218	.227	.241	.260	.251	.243	.241	.240	....	.242
Newark, N. J.	.240	.212	.213	.213	.223	.236	.236	....	.223	.226	.228	.231	.231
Portland, Ore.	.220	.218	.220	.223	.222	.245	.250	.251	.232	.227	.227	.227	.229
St. Louis, Mo.	.250	.253	.255	.254	.259	.275	.272	.268	.259	.255	.251	.250	.253
St. Paul, Minn.	.220	.221	.231	.234	.249	.269	.288	.284	....	.276	.277	.272	.272
Salt Lake City, Utah	.241	.241	.238	.237	.237	.257	.253	....	.252	.260	.246	.245	.245
Seattle, Wash.	.232	.234	.237	.250	.255	.276	.277	.272	.271	.268	....	.261	.261
Sioux Falls, S. D.	.236	.234	.238	.236	.243	.248	.257	.264	.264	.258	.266	.268	.271
South Bend, Ind.	.245	.244	.244	.246	.256	.266	.267	....	.258	.248	.239	.240	.243
Spokane, Wash.	....	.245	.238	.257	.266	.273	.283	.285	.273	.273	....	.262	.250
Syracuse, N. Y.	.234	.232	.232	.232	.232	.245	....	....	....	....	....	....	....
Utica, N. Y.	....	....	....	....	....	....	....	....	....	....	....	.251	.239
White Plains, N. Y.	.235	.238	.241	.240	.249	.256	.286	.266	.262	.258	....	.260	.258

	1936				1937				1938				1939
	Feb.	May	Aug.	Nov.	Feb.	May	Aug.	Nov.	Feb.	May	Aug.	Nov.	Feb.
Albuquerque, N. M.	.234	.251	.257	.260	.269	.277	.279	.277	.274	.271	.277	.272	.272
Charleston, W. Va.	.228	.224	.227	.235	.236	.245	.262	.260	.259	.248	.246	.245	.244
Cincinnati, Ohio	.242	....	.247	.242	.237	....	.280	.261	.248	....	.264	.255	.239
Cleveland, Ohio	.251	....	.257	.259	.263	....	.291	.286	.274	....	.267	.267	.268
Columbus, Ohio	.230	.225	.244	.236	.247	.260	.283	.254	.237	.237	.247	.239	.237
Dallas, Tex.	....	.232	.235	.235	.246	.253	.253	.253	....	.239	.251	.239	.235
Harrisburg, Pa.	.224	.226	.233	.233	.240	.250	.250	.243	.242	.243	.237	.237	.238
Houston, Tex.	....	.237	.239	.239	.247	.258	.257	.256	.249	.243	.250	.246	.246
Jackson, Miss.	.222	.222	.224	.227	.234	.245	.255	.249	.253	.255	.253	.253	.253
Lexington, Ky.	.208	.209	.218	.218	....	.229	.238	.233	.225	.220	.222	.228	.236
Little Rock, Ark.	.217	.216	.217	.214	.216	.220	.217	.216	.215	.215	.215	.217	.216
Los Angeles, Calif.	.221	.218	.220	.228	.242	.250	.250	.247	.245	.238	.238	.228	.225
Louisville, Ky.	.224	.222	.226	.231	....	.255	.253	.249	.244	.238	.241	.243	.243
Memphis, Tenn.	.202	.210	.212	.213	.232	.239	.240	.242	.236	.236	.236	.239	.243
Nashville, Tenn.	.210	.212	.212	.213	.220	.226	.229	.228	.214	.209	.212	.213	.212
New Orleans, La.	.212	.212	.216	.231	.237	.243	.251	.255	.255	.259	.263	.249	.244
Philadelphia, Pa.	.191	.204	.207	.212	.230	.249	.249	.240	.230	.232	.226	.224	.225
Phoenix, Ariz.	.252	.253	.254	.252	.252	.281	.283	.281	.279	.274	.266	.269	.257
Pittsburgh, Pa.	.228	.241	.242	.254	.265	.281	.283	.280	.271	.280	.270	.267	.269
Reno, Nev.	.254	.263	.263	.265	.265	.276	.278	.278	.276	.273	.273	.274	.274
San Antonio, Tex.	.228	.228	.231	.231	.243	.260	.260	.259	.254	.252	.252	.247	.245
San Diego, Calif.	.224	.224	.228	.233	.256	.254	.256	.258	.254	.244	.243	.243	.241
San Francisco, Calif.	....	.245	.250	.253	.262	.267	.269	.266	.265	.266	.264	.265	.266
Shreveport, La.	....	....	....	....	.228	.248	....	....	....	....	....	....	....
Wheeling, W. Va.	....	....	....	.241	.246	....	.271	.277	....	.262	.252	.250	.258
Wilmington, Del.	.217	.222	.221	.223	.229	.241	.242	.242	.246	.246	.246	.246	.240

	1936				1937				1938				1939
	Mar.	June	Sept.	Dec.	Mar	June	Sept.	Dec.	Mar.	June	Sept.	Dec.	Mar.
Asheville, N. C.	.199	.200	....	.206	....	.218	....	.225	.227	.216	.212	.211	....
Atlanta, Ga.	.202	.206	.207	.214	.218	.221	.227	.219	.220	.217	.211	.209	....
Baltimore, Md.	.184	.209	.216	.221	.225	.224	.224	.215	.214	.208	.206	.205	....
Birmingham, Ala.	.217	.224	.232	....	....	.252	.253	.253	.254	.253	.244	.236	....
Boston, Mass.	.241	.246	.249	.247	.266	.277	.278	.275	.268	.251	.262	.266	....
Chicago, Ill.	.273	.281	.283	.285	.295	.301	.299	.301	.293	.289	.282	.285	....
Columbia, S. C.	.193	.196	.196	.200	.195	.203	.203	.203	.199	.199	.203	.204	....
Cumberland, Md.	.226	.226	.228	.229	.236	.239	.237	.235	.233	.231	.230	.227	....
Denver, Colo.	.254	.250	.254	.255	.260	.280	.282	.276	.273	.269	.274	.268	....
Hartford, Conn.	.235	.235	.234	.241	.255	.264	.264	.253	.245	.239	.242	.245	....
Manchester, N. H.	.226	.228	.228	.232	.235	.242	.242	.233	.227	.225	.226	.231	....
Miami, Fla.	....	....	....	....	....	....	....	....	....	.232	....	....	....
Milwaukee, Wis.	.224	.232	.222	.231	.275	.271	.251	.251	.265	.262	.240	.240	....
New Haven, Conn.	.230	.231	.231	.234	.242	.246	.246	.243	.242	.234	.234	.234	....
Oklahoma City, Okla.	.220	.226	.227	.229	.237	.243	.243	.244	.244	.243	.243	.245	....
Omaha, Neb.	.233	.232	.232	.237	.247	.249	.255	.249	.243	.242	.242	.238	....
Oshkosh, Wis.	.229	.232	.235	.241	.232	.253	.256	.251	.251	.252	.246	.246	....
Peoria, Ill.	.259	.259	.260	.263	.274	.284	.284	.279	.280	.279	.270	.268	....
Portland, Me.	.214	.214	.219	.219	.219	.238	.242	.238	.234	.234	.221	.219	....
Providence, R. I.	.228	.229	.232	.235	.240	.247	.247	.250	.250	.247	.246	.246	....
Raleigh, N. C.	.211	.211	.215	.218	.227	.234	.236	.230	.226	.226	.221	.220	....
Richmond, Va.	.207	.203	.203	.208	.217	.218	.222	.224	.220	.219	.215	.212	....
Roanoke, Va.	.190	.207	.195	.200	.221	.228	.212	.217	.233	.235	.221	.221	....
Rutland, Vt.	.222	.222	.223	.223	.237	.241	.244	.244	.238	.238	.231	.228	....
Salisbury, N. C.	....	....	....	....	....	.198	.202	.196	.192	....	....	.198	....
Springfield, Ill.	.271	.271	.271	.278	.289	.291	....	....	.294	.296	.284	.284	....
Tampa, Fla.	.224	.224	.226	.227	.234	.238	.238	.232	.239	.237	.231	.230	....
Washington, D. C.	.205	.207	.210	.226	.246	.260	.251	.251	.260	.261	.243	.244	....
West Palm Beach, Fla.	.245	.246	.249	.252	.264	.267	.269	.266	.259	.253	.242	.243	....
Wichita, Kan.	.215	.215	....	.220	.241	.238	....	....	....	.244	....	.249	....

Office and Apartment Building Cost Analysis

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***From articles in the April and July, 1938, issues of* Construction Methods and Equipment**

THE COST DATA on a typical New York tower-type office building, given in Table I, have been prepared by breaking down the costs as of Sept. 1, 1934, between labor and materials and in accordance with subdivisions or trades usually found in a contractor's estimate.

September, 1934, is chosen as a base because the fall of 1934 was a period in which prices were stabilized at values reasonably fair to producer and consumer alike. The increased cost of labor has been calculated as of Jan. 1, 1938, from the data shown in Table II on union labor rates at the times above mentioned. The increased costs of materials likewise have been calculated as of Jan. 1, 1938, using the data in Table III. These material price changes are based upon the actual selling prices and not upon list prices.

Another office building of different specifications and finishing materials might vary slightly from the figures shown. Yet the average is considered by the writer to be fair and typical for an office building on the 1934 wage scale.

It will be noted from columns (e) and (h) of Table I that the total average increase in labor is 19.6 per cent and in materials 11.4 per cent, making a total average increase in the building cost of 14 per cent, equivalent to $560,960 or 8.4c. per cu.ft. of building, between Sept. 1, 1934 and Jan. 1, 1938.

In order to check the accuracy of this increase in cost the writer has investigated actual costs of other types of buildings which lend themselves to comparison because of repetitive characteristics of design, architecture, materials and size. The results are shown in Table IV.

Apartment buildings

Few types of multi-story buildings are more standard than apartments, yet they vary in cost from about 30 to 90c. per cu.ft. in New York City,

TABLE I — TYPICAL FIRST-CLASS NEW YORK OFFICE BUILDING, TOWER TYPE

ANALYSIS OF COST BY TRADES

Showing Increase Jan. 1, 1938 over Sept. 1, 1934 (20 Stories; 530,000 sq. ft.; 6,670,000 cu. ft.)

	Labor and Materials as of Sept. 1, 1934		Labor Only	% Increase in Labor Jan. 1, 1938 Over Sept. 1, 1934	Labor Increase	Materials Only	% Increase in Mat'ls. Jan. 1, 1938 Over Sept. 1, 1934	Materials Increase
	Amount $	% of Total	% of Total		% of Total	% of Total		% of Total
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1. Excavation	$60,000	1.500	0.50	9.0	.04	1.00	10.0	0.10
2. Foundations	100,000	2.500	1.25	24.0	.30	1.25	5.7	.07
3. Brick Masonry	130,000	3.250	1.75	26.0	.46	1.50	6.8	.10
4. Fireproof Partitions	100,000	2.500	1.25	26.0	.32	1.25	4.5	.06
5. Carpentry	20,000	0.500	0.28	22.0	.06	.22	16.0	.03
6. Concrete Floor Arches	170,000	4.250	1.92	23.0	.44	2.33	9.2	.21
7. Cement Fill & Finish	100,000	2.500	1.15	24.0	.28	1.35	0.0	0.00
8. Waterproofing-Dampproofing	25,000	0.625	.28	25.0	.07	.345	9.5	.03
9. Roofing & Sheet Metal	30,000	0.750	.30	23.0	.07	.45	21.0	.10
10. Structural Steel	440,000	11.000	2.20	18.0	.42	8.80	11.1	.98
11. Cut Stone & Terra Cotta	200,000	5.000	1.50	22.0	.33	3.50	0.0	.00
12. Ornamental Iron & Bronze	130,000	3.250	0.65	25.0	.16	2.60	25.0	.65
13. Steel Windows	40,000	1.000	.25	25.0	.06	.75	11.0	.08
14. Venetian Blinds	13,000	0.325	.03	25.0	.01	.295	0.0	.00
15. Rubber & Cork Floors	25,000	0.625	.16	10.0	.02	.465	20.0	.09
16. Hollow Metal	120,000	3.000	.75	25.0	.19	2.25	20.0	.45
17. Plastering & Lathing	160,000	4.000	2.50	33.3	.83	1.50	14.0	.21
18. Glass & Glazing	28,000	0.700	.21	17.8	.04	.49	21.0	.10
19. Painting	55,000	1.375	.80	16.6	.13	.575	0.0	.00
20. Finish Hardware	30,000	0.750	.15	25.0	.04	.60	0.0	.00
21. Marble & Structural Glass	180,000	4.500	1.10	12.5	.14	3.40	3.0	.10
22. Tile & Terrazzo	40,000	1.000	.40	10.0	.04	.60	0.0	.00
23. Plumbing & Drainage	200,000	5.000	1.70	16.7	.28	3.30	12.0	.40
24. Heating & Ventilating	240,000	6.000	1.60	10.0	.16	4.40	14.0	.62
25. Electric Wiring & Fixtures	300,000	7.500	1.95	42.9	.82	5.55	13.7	.76
26. Elevators & Elev. Doors	370,000	9.250	2.77	0.0	.00	6.48	27.0	1.75
27. Sprinkler System	20,000	0.500	.10	16.7	.02	.40	10.0	.04
28. Air Conditioning	200,000	5.000	1.86	15.0	.28	3.14	17.0	.53
29. General Conditions	140,000	3.500	1.75	20.0	.35	1.75	12.0	.21
30. Plant & Equipment (General)	25,000	0.625	.09	25.0	.02	.535	8.0	.04
31. Insurance (General)	20,000	0.500	.00	....	.00	.50	4.0	.02
32. Surety Bond Premium	48,000	1.200	.00	....	.00	1.200	0.0	.00
33. Overhead (General Office)	121,000	3.025	.00	....	.00	3.025	0.0	.00
34. Profit	120,000	3.000	0.00	....	0.00	3.000	0.0	0.00
Totals	$4,000,000	100.000	32.00	....	6.28	68.00	.....	7.73

$4,000,000 ÷ 6,670,000 = $0.60 per cubic foot, not including tenant changes.

Total increase in labor $\frac{6.28}{32.00}$ = 19.6%

Total increase in materials $\frac{7.73}{68.00}$ = 11.4%

	Total Cost Sept. 1, 1934		Total Cost Jan. 1, 1938
Total labor, 32% of $4,000,000	$1,280,000	× 1.196 =	$1,530,880
Total materials, 68% of $4,000,000	2,720,000	× 1.114 =	$3,030,080
Total labor & materials	$4,000,000		$4,560,960

Average increase of labor and materials = $0.084 per cu. ft., or 14.0%.

TABLE II — WAGE SCALES IN NEW YORK CITY

COMPARISON BETWEEN YEARS 1934, 1937, 1926 AND 1929

Rates per Hour (3-Year)

	1934		Jan. 1, 1938		Increase	1926		1929	
	$	Hr.	$	Hr.	Per Cent	$	Hr.	$	Hr.
1. Bricklayers	1.50	(8)	1.88 4/7	(7)	25.7	1.75	(8)	1.87½	(8)
2. Bricklayers Tenders	0.90	(8)	1.14 2/7	(7)	27.0	1.12½	(8)	1.23½	(8)
3. Carpenters	1.40	(8)	1.75	(7)	25.0	1.50	(8)	1.65	(8)
4. Cement Finishers	1.40	(8)	1.75	(7)	25.0	1.50	(8)	1.65	(8)
5. Electricians	1.40	(8)	2.00	(6)	42.9	1.50	(8)	1.65	(8)
6. Engineers, Hoisting	1.65	(8)	2.00	(7)	21.2	1.75	(8)	1.92½	(8)
7. Elevator Constructors	1.40¼	(8)	1.40¼	(8)	0.0	1.50	(8)	1.65	(8)
8. Iron Workers, Struct.	1.65	(8)	1.92½	(8)	16.7	1.75	(8)	1.92½	(8)
9. Iron Workers, Orn.	1.40	(8)	1.75	(7)	25.0	1.50	(8)	1.65	(8)
10. Laborers, Common	.90	(8)	.95	(8)	5.6	.81½	(8)	1.03⅛	(8)
11. Laborers, Conc. Wkrs.	.93¾	(8)	1.14 2/7	(7)	22.0	1.00	(8)	1.16⅞	(8)
12. Lathers, Metal	1.40	(8)	1.75	(8)	25.0	1.50	(8)	1.65	(8)
13. Painters	1.28 4/7	(8)	1.50	(7)	16.6	1.50	(8)	1.65	(8)
14. Plasterers	1.50	(8)	2.00	(6)	33.3	1.75	(8)	1.92½	(8)
15. Plasterers, Tenders	1.06¼	(8)	1.42	(6)	33.3	1.21⅞	(8)	1.34	(8)
16. Plumbers	1.50	(8)	1.75	(7)	16.7	1.50	(8)	1.65	(8)
17. Roofers, Composition	1.28¼	(8)	1.60	(7)	24.8	1.37½	(8)	1.51¼	(8)
18. Roofers, Slate & Tile	1.57¾	(8)	1.86	(7)	17.9	1.68⅜	(8)	1.85⅛	(8)
19. Sheet Metal Workers	1.40	(8)	1.75	(7)	25.0	1.50	(8)	1.65	(8)
20. Stone Masons	1.56¼	(8)	1.88 4/7	(7)	20.7	1.75	(8)	1.92½	(8)
21. Steam Fitters	1.50	(8)	1.65	(8)	10.0	1.50	(8)	1.65	(8)
22. Marble Setters	1.50	(8)	1.68¾	(8)	12.5	1.50	(8)	1.68¾	(8)
23. Tile Setters	1.43¾	(8)	1.56¼	(8)	8.7	1.50	(8)	1.68¾	(8)
24. Glaziers	1.40	(8)	1.65	(8)	17.8	1.50	(8)	1.65	(8)
Average (of 24)	1.373	..	1.661	..	21.0%*	1.435	..	1.643	..

Increase, average Jan. 1, 1938 over 1926 = 15.8% Increase, average Jan. 1, 1938 over 1929 = 1.0%

* In calculating these averages, each trade has equal weight, whereas in Table I the numbers of men employed in each trade are not equal, which accounts for difference between 21.0 and 19.6%.

depending upon the type of construction, shape of building, materials selected, character of facilities and architectural treatment. Despite this variation, a comparison of the more common types in the low-priced apartment building field may provide some useful data.

Three types of construction—non-fireproof, bar-joist (fire-protected), and fireproof—have been selected, as shown in Table V. The cost of each has been broken down into its constituent items or trades and shown both by amount and cubic foot of building in parallel columns as of Jan. 1, 1938. While an effort has been made to choose examples which merely represent the types involved, attention is called to the fact that the average size of room is not the same in all three cases, so that some small allowance should be made in comparing one with the other, since smaller rooms mean higher costs.

Specifications for each of the three types of buildings are given in footnotes to the table. It may be noted in addition that the excavations for all three buildings were in earth, and that there were no exceptional foundation problems. All kitchens had linoleum floors, and all kitchen cabinets were wood, prefabricated. Elevators were standard apartment house types, push-button control, with swinging shaft doors.

Item 42, "Contingencies", while often omitted, is intended to cover such unpredictable but none the less real costs as strikes, wage increases, etc.

Items 43 and 44 usually are combined in one, but item 43 must be paid by the owner in some degree whether or not he employs a contractor.

TABLE III — BASIC MATERIALS FOR A NEW YORK OFFICE BUILDING

Price Changes—Sept. 1, 1934 to Jan. 1, 1938

(Prices are for materials delivered to the building)

Materials	Per Cent Increase	Per Cent Decrease
1. Brick, common	8.7	
2. Face brick, light gray, smooth	2.9	
3. Backup Tile, 8 in	5.0	
4. Partition Tile, 4 in., T.C	4.7	
5. Lime, Masons, hydrated		7.4
6. Cement, Portland		10.6
7. Steel Bar, Reinforcing	20.0	
8. Gravel	9.1	
9. Sand	no change	
10. Lumber, Pine, for forms	17.9	
11. Linseed Oil, boiled	5.5	
12. Lead, white		2.5
13. Turpentine		32.7
14. Plaster, finishing	20.0	
15. Plaster, neat	22.2	
16. Metal Lath and Furring Channels	17.0	
17. Structural Steel, fabricated	11.1	
18. Granite, gray, 4-cut	10.0	
19. Limestone, cut, machine smooth	no change	
20. Roofing, felt and asphalt	20.0	
21. Copper Flashing	25.0	
22. Miscellaneous Iron, fabricated	26.0	
23. Ornamental Bronze, fabricated	25.0	
24. Terra Cotta, architectural	10.0	
25. Marble, domestic, Tennessee	5.0	
26. Structural Glass	no change	
27. Steel Windows, double hung		11.0
28. Steel Windows, casement		20.0
29. Bronze Windows, double hung	no change	
30. Plumbing Fixtures	22.0	
31. Brass Pipe and Fittings	25.0	
32. Steel Pipe	5.0	
33. Pipe Covering	no change	
34. Cast Iron Pipe	no change	
35. Cast Iron Radiators		16.0
36. Sheet Metal, Galvanized	22.0	
37. Electric Conduit	17.0	
38. Wire, rubber covered	no change	
39. Switches and Receptacles	10.0	
40. Switchboards and Panels	25.0	
41. Underfloor Duct	no change	

TABLE IV — INCREASE IN COST OF VARIOUS TYPES OF NEW YORK BUILDINGS

FROM SEPT. 1, 1934 TO JAN. 1, 1938

Type	Cost per Cubic Foot		Per Cent Increase
	Sept. 1, 1934	Jan. 1, 1938	
Schools, Elementary	$0.46	$0.53	15.3
Fireproof Apartments, 12-Story	0.44	0.51	15.9
Semi-Fireproof Apartments, 5-Story Walk-up	0.31	0.36	16.1
Office Buildings (See Table 1)	0.60	0.684	14.0

TABLE V — TYPICAL NEW YORK CITY APARTMENT HOUSES

SHOWING COST COMPARISON OF DIFFERENT TYPES, AS OF JAN. 1, 1938

No. Stories	Non-Fireproof [1] Wall Bearing 5 & Bas't		Bar Joist [2] Steel Frame 9 & Bas't		Fireproof [3] Steel Frame 12 & Bas't	
No. Rooms	580		415		1400	
No. Aparts.	145		125		350	
Floor-to-floor Ht.	9 ft. 6 in.		9 ft. 4 in.		9 ft. 4 in.	
Cu. Ft. per Room	2,940		3,600		2,560	
Total Floor Area	180,000		153,000		408,000	
Cube	1,700,000		1,500,000		4,000,000	
	Total	Per Cu.Ft.	Total	Per Cu.Ft.	Total	Per Cu.Ft.
1. Excavation	$9,000	$0.0053	$8,200	$0.0055	$60,000	$0.0150
2. Concrete Foundations	10,400	.0061	17,000	.0113	92,000	.0230
3. Brickwork	78,000	.0458	53,700	.0358	195,000	.0488
4. Tile Partitions	7,000	.0041	9,000	.0060	105,000	.0262
5. Rough Carpentry & Set Millwork	39,000	.0230	20,700	.0138	42,000	.0105
6. Millwork (Fin'd. Carp'y.)	18,000	.0106	14,700	.0098	32,400	.0081
7. Concrete Arches	7,200	.0042	24,000	.0160	116,000	.0290
8. Cement Work	7,000	.0041	12,600	.0084	49,600	.0124
9. Bar Jsts., Top Lath & Concrete	.....	.....	30,000	.0200	.....	.....
10. Wood Windows & Caulking	5,500	.0032	.....	.....	.....	.....
11. Steel Windows & Caulking	.....	.....	9,300	.0062	22,000	.0055
12. Hollow Metal & Kalamein	13,000	.0076	12,300	.0082	60,800	.0152
13. Structural Steel	15,200	.0089	57,400	.0383	224,000	.0560
14. Misc. & Ornamental Iron	14,800	.0087	10,200	.0068	24,000	.0060
15. Sheet Metal & Roofing	5,200	.0031	4,200	.0028	10,400	.0026
16. Plastering & Lathing	77,000	.0453	83,500	.0556	155,000	.0388
17. Glass & Glazing	1,900	.0011	6,000	.0040	4,000	.0010
18. Painting	17,900	.0105	17,100	.0114	46,400	.0116
19. Finish Hardware	6,000	.0035	6,100	.0041	14,800	.0037
20. Finished Wood Floors	17,600	.0104	20,200	.0136	56,000	.0140
21. Ceramic Tile	14,000	.0082	11,800	.0079	32,000	.0080
22. Bathroom Accessories	1,200	.0007	900	.0006	3,200	.0008
23. Terrazzo	2,700	.0016	3,500	.0023	8,000	.0020
24. Waterproofing & Dampproofing	2,800	.0017	2,400	.0016	12,400	.0031
25. Weatherstrips	1,500	.0009	.....	.....	.....	.....
26. Linoleum	2,800	.0017	3,900	.0026	7,600	.0019
27. Medicine Cabinets	1,300	.0008	1,100	.0007	3,600	.0009
28. Mail Boxes	300	.0002	300	.0002	800	.0002
29. Incinerators	1,400	.0008	600	.0004	1,200	.0003
30. Kitchen Cabinets	14,000	.0082	12,200	.0081	32,000	.0080
31. Gas Ranges	7,600	.0045	6,600	.0044	16,000	.0040
32. Refrigerators	13,800	.0081	11,900	.0079	34,000	.0085
33. Insect Screens	3,400	.0020	5,400	.0036	12,400	.0031
34. Window Shades	700	.0004	1,100	.0007	2,000	.0005
35. Plumbing	50,000	.0294	47,300	.0315	180,000	.0450
36. Heating & Ventilating	40,600	.0239	42,200	.0281	105,000	.0262
37. Electric Wiring & Fixtures	26,200	.0154	27,700	.0185	78,000	.0195
38. Elevators	25,000	.0147	12,700	.0085	52,000	.0130
39. Gen'l. Conditions (Job Overhead)	20,000	.0118	22,800	.0152	64,800	.0162
40. Plant (Gen'l. Contr's. Only)	1,500	.0009	1,200	.0008	4,000	.0010
41. Insurance (General)	1,500	.0009	1,800	.0012	4,800	.0012
42. Contingencies, 1½ per cent.	8,800	.0052	9,900	.0066	28,800	.0072
43. General Office Overhead	14,200	.0084	16,500	.0110	48,000	.0120
44. Fee-Commission-Profit	24,000	0.0141	30,000	0.0200	80,000	0.0200
	$629,000	$0.3700	$690,000	$0.4600	$2,120,000	$0.5300

[1] Non-Fireproof Building: Concrete footings, brick walls, common brick facing, brick windowsills, cast stone copings, double-hung wood windows, short-span cinder concrete arches and steel framing on first floor, wood joists on steel beams and columns above first floor, gypsum partitions in basement, wood partitions above first floor except brick around stairs and elevators, wood doors except kalamein for corridors, combination metal bucks, wood furring of exterior walls, and metal lath on walls and ceilings. Floors generally wood over sub-floor, corridors terrazzo, steel stairs cement-filled. Attic ceiling insulated with rockwool. Heating system is one-pipe steam, oil-fired boilers.

[2] Bar-Joist Building: Steel skeleton frame, concrete footings and basement walls, 4-in. brick facing and 6-in. backup tile in exterior walls, terra cotta coping, steel residential casement windows, metal sills, hollow tile and 2-in. solid plaster partitions, top lath and 2-in. concrete over bar joists with monolithic finish, ceiling lath attached to bar joists, combination metal bucks, wood doors except kalamein for corridors, metal furring of exterior walls. Floors generally wood laid on mastic, corridors terrazzo, steel stairs cement-filled. Heating system is two-pipe steam, oil-fired boilers.

[3] Fireproof Building: Concrete footings, concrete basement walls, 13-in. brick exterior walls, common brick facing, terra cotta coping, brick windowsills, steel frame, steel residential casement windows, metal sills, hollow tile partitions, short-span cinder concrete arches, combination metal bucks. Doors and floors same as for building 1. Heating system same as for building 2.

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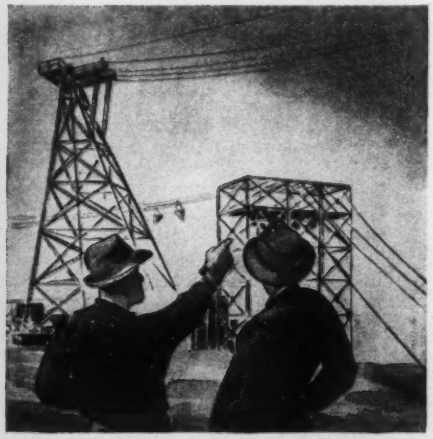

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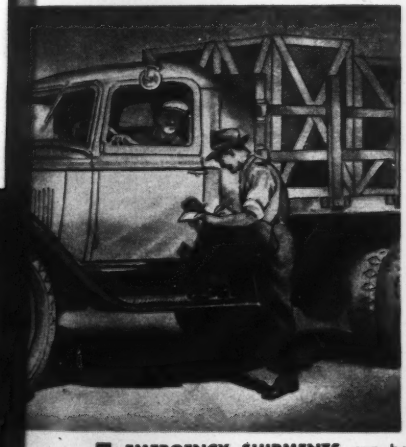

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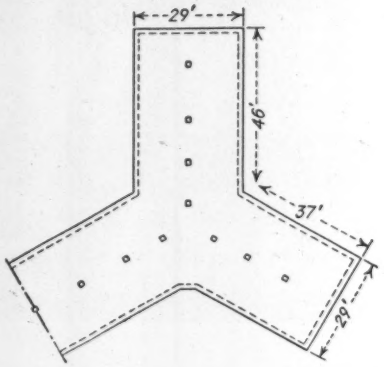
Wall and Floor Cost Estimates

THE PUBLIC HOUSING PROJECTS being built by the New York City Housing Authority with United States Housing Authority funds have been noted for the low costs achieved. In developing the design for the Queensbridge project, the accompanying alternate estimates for several types of construction were worked out. The buildings, now under construction by the Cauldwell-Wingate Co., general contractors, utilize the type II floor and a variation of the type H wall in which the bottom two stories are 12-in. solid brick and the top four stories are of 4-in. brick and 8-in. terra cotta.

The accompanying detail cost estimates were made by Elwyn E. Seelye, structural engineer, for the Queensbridge project associated architects: William F. R. Ballard, chief architect; Henry S. Churchill; Frederick G. Frost; and Burnett C. Turner.



Wall and column plan of typical unit in Queensbridge Housing at New York.

TABLE I—COST ESTIMATES OF DIFFERENT FLOOR AND WALL DESIGNS

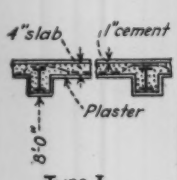
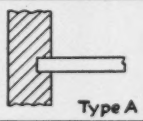
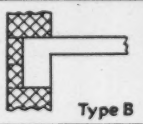
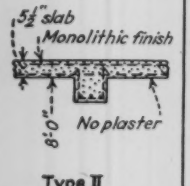
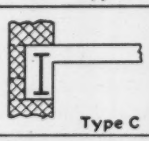
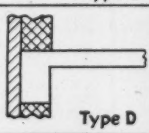
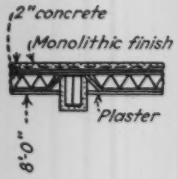
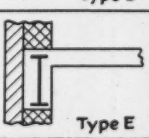
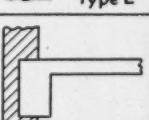
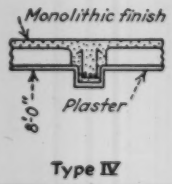
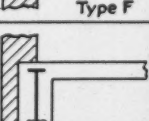
ALTERNATE FLOOR FRAMING FOR TYPICAL FLOORS Area = 4,100 sq. ft.			ALTERNATE WALL CONSTRUCTION FOR ONE TYPICAL STORY Story height assumed 9'-2"— Wall area 2,850 sq. ft.		
SKETCH	DESCRIPTION	COST	SKETCH	DESCRIPTION	COST
 Type I	Cinder concrete arch, Short span, Structural steel, bearing wall Structural steel 11 tons @ 99.00 — 1089.00 Cinder arches 3,900 sq. ft. @ 35¢ — 1363.00 Column fireproof 100 L.F. @ 1.00 — 100.00 1" cement finish 3,900 sq. ft. @ 12¢ — 468.00 Plaster ceiling 3,900 sq. ft. @ 11¢ — 429.00 Insurance and job overhead 10% — 100.00 Total — $3549.00 Debit increased story height (6") — 167.00 Debit cracks in finish — $3716.00 If combined with skeleton wall based on lower unit price for steel — 3672.00		 Type A	12" brick bearing wall Common brick laid up as face brick	$3078.00
			 Type B	12" cinder block on concrete skeleton	Wall 1995.00 Skeleton 1065.00 $3060.00
 Type II	Reinforced concrete beam and slab, smooth surface bearing wall Conc. (1:4½ mix.) 80 cu. yd. @ 9.00 — 720.00 Reinf. steel 5½ tons @ 110.00 — 605.00 Forms for slabs, beams, Interior columns, Trimming ceiling, Floor finish, Insurance and job charges — 4,100 sq. ft. @ 41¢ — 1681.00 Extra cost ceiling paint 3,700 sq. ft. @ .02 — 74.00 No plaster on ceiling, Plaster on cols. Total — $3080.00 Credit decreased story height (5½") — 154.00 — $2926.00		 Type C	12" cinder block on steel skeleton	Wall 1995.00 Skeleton 1196.00 $3191.00
			 Type D	4" common brick laid up as face brick and 6" backup tile of T.C. block on concrete skeleton	Wall 2565.00 Skeleton 1065.00 $3630.00
 Type III	Bar joist and long span structural steel, bearing wall Structural steel 6½ tons @ 110.00 — 715.00 Bar joists 4 tons @ 114.00 — 456.00 Conc. topping 3,900 sq. ft. @ 7.4¢ — 289.00 Mesh 3,900 sq. ft. @ 1.65¢ — 65.00 Top lath 435 sq. yd. @ 39¢ — 170.00 ⅞" gyp plaster and lath 420 sq. yd. @ 1.90 — 798.00 Solid slabs Conc. 5 cu. yd. @ 10.00 — 50.00 Reinf. steel ¼ ton @ 110.00 — 28.00 Forms 250 sq. ft. @ 20¢ — 50.00 Fireproofing Beams 240 L.F. @ 75¢ — 180.00 Columns 100 L.F. @ 1.00 — 100.00 Floor finish 3,900 sq. ft. @ 6¢ — 234.00 Insurance and job overhead 10% — 196.00 Total — $3331.00 If combined with skeleton wall based on lower unit price for steel — 3305.00 Debit special floor finish		 Type E	4" common brick laid up as face brick and 6" backup tile of T.C. block on steel skeleton	Wall 2565.00 Skeleton 1196.00 $3761.00
			 Type F	8" solid brick, common brick laid up as face brick on concrete skeleton	Wall 2250.00 Skeleton 1065.00 $3315.00
 Type IV	Metal pan and joist slabs and concrete beams Concrete (1:4½ mix.) 60 cu. yd. @ 9.00 — 540.00 Reinf. steel 4½ tons @ 110.00 — 495.00 Metal tile & joist forms 3,900 sq. ft. @ 20¢ — 780.00 Beam forms 450 sq. ft. @ 25¢ — 113.00 Column forms 385 sq. ft. @ 30¢ — 115.00 Lath and plaster 3,900 sq. ft. @ 19½¢ — 761.00 Floor finishing 3,900 sq. ft. @ 06¢ — 234.00 Insurance and job overhead 10% — 304.00 Total — $3342.00 Credit decreased story height (2") — 58.00 — $3284.00		 Type G	8" solid brick, common brick laid up as face brick on steel skeleton	Wall 2250.00 Skeleton 1196.00 $3446.00
			Combination walls for 6 stories 2 top stories 4" brick + 6" T.C. block 2 lower stories 4" brick, 8" T.C. block Bottom 2 stories 12" solid brick Type H	Combination bearing walls (6 stories) 2 top stories (type D above) 2 x 2565 = 5130.00 2 lower stories (same as type D above except 8" T.C. backup in lieu of 6" T.C.) 2 x 2708 = 5416.00 Bottom 2 stories (type A above) 2 x 3078 = 6156.00 Total $16702.00 Average cost per story 16702 / 6 = $2784.00	

TABLE II — QUEENSBRIDGE HOUSING UNIT COSTS USED IN TABLE I

Unit Costs Assumed		
Cement	$2.10	per bbl.
Sand	1.25	" yd.
Gravel	2.60	" "
Brick	14.00	" M
6" T. C. Backup (6"x12"x12")	140.00	" "
12" Cinder block (12"x8"x16")	230.00	" "
Reinf. Steel (in place)	110.00	" T
Bar Joists (including Bridging)		
Material	$87.50	per T
Trucking	1.50	" "
Erection	20.00	" "
Insurance	3.00	" "
Job Overhead	2.00	" "
Total	$114.00	per Ton

Labor Rates	(Per. Hr.)
Carpenters	$1.75
Carpenters' Helper	.75
Bricklayers	1.89
Bricklayers' Helper	1.15
Plasterers	2.00
Plasterers' Helper	1.42
Hod Carriers	1.15
Laborers	1.15

Structural Steel Prices Assumed.	Per Ton (Erected)
(a) Short Span — Skeleton Frame	$95.00
(b) " " — Bearing Wall	99.00
(c) Long Span — Skeleton Frame	106.00
(d) " " — Wall Bearing	110.00

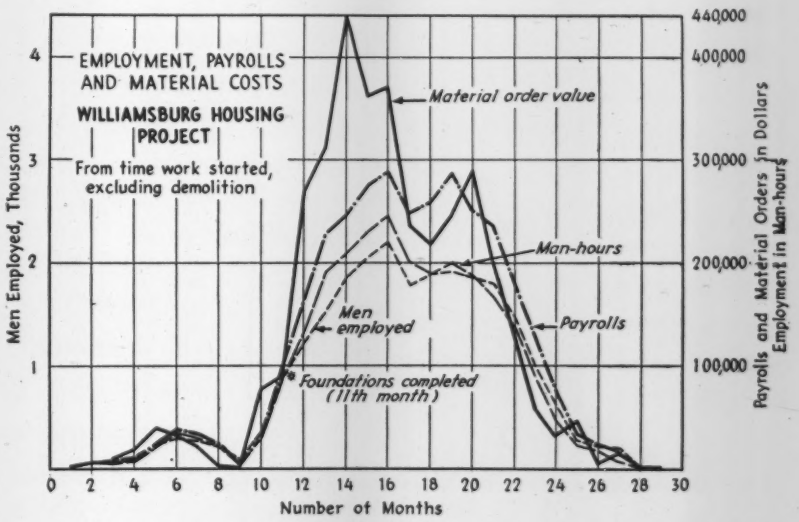
Concrete (1:4½ Mix)	
2 Bbls. Cement @ $2.10	$4.20
.423 cu. yds. Sand @ 1.50	.60
.846 " " Gravel @ 2.60	2.20
	$7.00
Labor	1.50
Insurance and Job Overhead	.50
Total (cu. yd.)	$9.00

Forms for Solid Concrete Slab and Beam Alternate	
Forms (Incl. Beams and Cols.)	$.26
Trimming Ceilings	.04
Floor Finish	.05
	.35
Labor Insurance	.03
	.38
Job Overhead	.03
Cost per Sq. Ft.	$.41

Wall, Costs per Sq. Ft.	
12" Brickwall	
19 bricks @ 1.4¢	$.27
Mortar	.06
Scaffold	.04
Labor	.55
Insurance	.06
Job Overhead	.10
Total	$1.08
12" Cinder Block	
Block	$.26
Mortar	.02
Scaffold	.04
Labor	.28
Insurance	.04
Job Overhead	.06
Total	$.70
4" Brick and 6" T. C. Backup	
Brick	$.10
6" T. C. Block	.14
Mortar	.04
Scaffold	.04
Labor	.45
Insurance	.05
Job Overhead	.08
Total	$.90
8" Brick	
Brick	$.19
Mortar	.04
Scaffold	.04
Labor	.40
Insurance	.05
Job Overhead	.07
Total	$.79

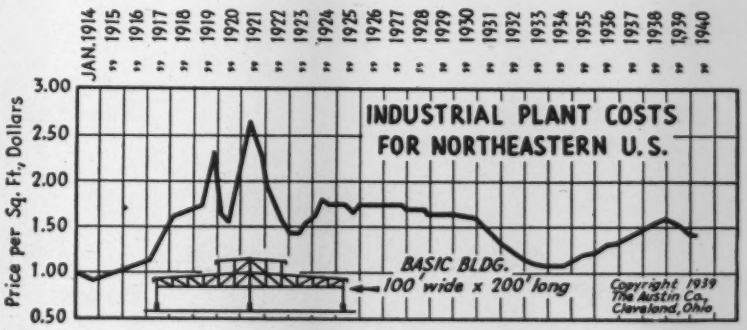
Budgeting Construction Payments

CONTRACTOR payrolls and expenditures for materials on a given job are, of course, not constant over the period covered by the work. Careful budgeting of funds is necessary. The record of payroll and material order values by months on the Williamsburg housing project in New York City (Starrett Bros & Eken, general contractors) is plotted on the accompanying chart from data prepared by the division of construction and public employment of the U. S. Bureau of Labor Statistics. It shows how contractor expenditures varied over a 2½-year period on a project consisting of a group of four-story reinforced concrete buildings with brick bearing walls whose construction cost, exclusive of land and landscaping, was about $8,500,000.

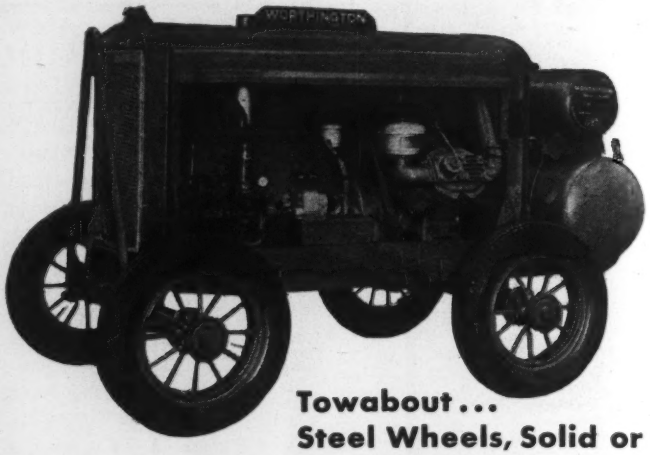

EMPLOYMENT, PAYROLLS AND MATERIAL COSTS
WILLIAMSBURG HOUSING PROJECT
From time work started, excluding demolition
Material order value
Man-hours
Men employed
Payrolls
Foundations completed (11th month)
Men Employed, Thousands
Payrolls and Material Orders in Dollars
Employment in Man-hours
Number of Months
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
1 2 3 4
100,000 200,000 300,000 400,000 440,000

Costs of Industrial Buildings

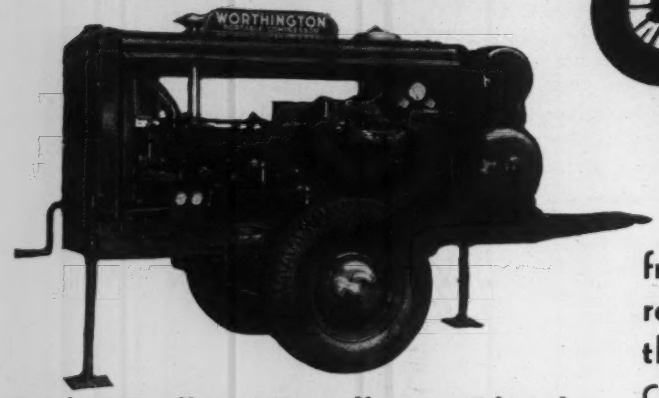
INDUSTRIAL building costs over a 25-yr. period have averaged $1.52 per sq. ft. according to the accompanying chart developed by The Austin Co., engineers and builders. The chart records the average actual construction cost per sq. ft. for 20,000 sq. ft. of one-story monitor-type industrial plants located in the area from the Mississippi Valley to the Atlantic Coast and north of the Mason-Dixon Line, a few larger cities excepted. The costs do not include heating, lighting and plumbing.



A Complete Line for EVERY TYPE OF JOB...



Towabout...
Steel Wheels, Solid or Pneumatic Tires



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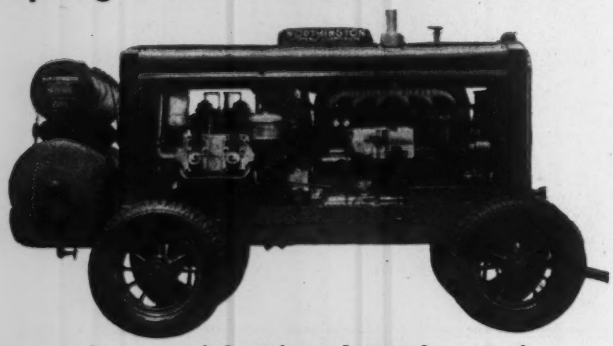

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Gasoline engine or diesel engine drive
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FOR ANY CAPACITY
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General Offices: HARRISON, NEW JERSEY

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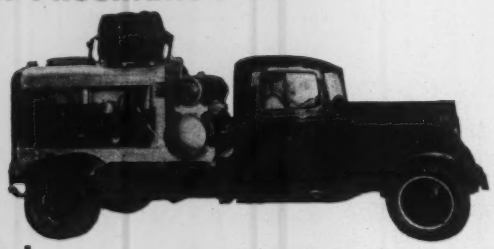
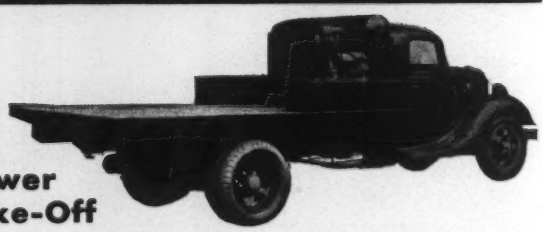


Truck Mounted



Power Take-Off

Costs of Thirty-three Completed PWA Housing Projects

Prepared in the Bureau of Labor Statistics, Division of Construction and Public Employment

Name and location of project	Dwelling units [1]			Rooms			Cost per cubic feet [4]
		Average cost			Average cost		
	Number [2]	Based on construction-contract price	Based on cost of dwelling facilities only [3]	Number [2]	Based on construction-contract price	Based on cost of dwelling facilities only [3]	
Thirty-three Projects	**14,122**	**$4,358**	**$4,126**	**49,827**	**$1,235**	**$1,169**	**$0.468**
Seventeen Southern Projects	**5,398**	**3,882**	**3,568**	**18,163**	**1,154**	**1,060**	**.451**
Atlanta, Ga.							
Techwood	604	3,307	2,688	2,124	940	764	.384
University Homes	675	2,780	2,487	2,343	801	717	.432
Birmingham, Ala.							
Smithfield Courts	544	3,160	2,913	1,588	1,083	998	.390
Charleston, S. C.							
Meeting Street Manor	214	5,086	4,922	706	1,542	1,492	.567
Columbia, S. C.							
University Terrace	122	4,570	4,031	415	1,344	1,185	.611
Dallas, Tex.							
Cedar Springs	182	4,286	4,032	602	1,296	1,219	.505
Enid, Okla.							
Cherokee Terrace	82	4,782	4,677	318	1,233	1,206	.499
Jacksonville, Fla.							
Durkeeville	217	3,624	3,000	709	1,109	918	.452
Lexington, Ky.							
Blue Grass Park	287	4,820	4,530	951	1,455	1,367	.462
Louisville, Ky.							
La Salle Place	213	4,859	4,498	809	1,279	1,184	.421
Memphis, Tenn.							
Dixie Homes	636	3,866	3,734	2,019	1,218	1,176	.484
Lauderdale Courts	449	5,139	4,847	1,574	1,466	1,383	.516
Miami, Fla							
Liberty Square	243	3,333	2,977	860	942	841	.356
Montgomery, Ala.							
Riverside Heights	100	3,209	2,934	324	990	905	.347
Patterson Courts	158	2,370	2,245	530	707	669	.464
Nashville, Tenn.							
Cheathem Place	314	4,680	4,354	1,045	1,406	1,308	.424
Oklahoma City, Okla.							
Will Rogers Courts	358	4,463	4,221	1,246	1,282	1,213	.506
Sixteen Northern Projects	**8,724**	**4,653**	**4,472**	**31,664**	**1,282**	**1,232**	**.477**
Atlantic City, N. J.							
Stanley S. Holmes	277	4,043	3,900	928	1,207	1,164	.491
Buffalo, N. Y.							
Kenfield	660	5,962	5,640	2,762	1,425	1,348	.515
Cambridge, Mass.							
New Towne Court	294	4,578	4,452	1,172	1,149	1,117	.481
Chicago, Ill.							
Julia C. Lathrop Homes	925	4,867	4,758	3,254	1,384	1,352	.515
Trumbull Park	468	5,367	5,195	1,747	1,438	1,392	.541
Cleveland, Ohio							
Cedar Central	654	3,608	3,380	2,312	1,021	956	.385
Outhwaite	579	4,183	3,811	2,166	1,118	1,019	.394
Lakeview Terrace	620	4,608	4,210	2,311	1,236	1,129	.454
Indianapolis, Ind.							
Lockfield Gardens	748	3,050	2,951	2,538	899	870	.349
Milwaukee, Wis.							
Parklawn	518	4,029	3,739	2,018	1,034	960	.334
New York City, N. Y.							
Williamsburg Homes	1,674	5,075	5,014	5,888	1,443	1,426	.558
Harlem River Homes	583	4,672	4,665	1,978	1,377	1,375	.554
Philadelphia, Penn.							
Hill Creek	258	6,494	6,195	999	1,677	1,600	.522
Stamford, Conn.							
Fairfield Court	148	4,643	4,559	506	1,358	1,333	.519
Toledo, Ohio							
Brand Whitlock Homes	266	5,023	4,732	913	1,463	1,379	.534
Wayne, Penn.							
Highland Homes	52	4,768	4,632	172	1,441	1,400	.557

[1] In general each project is made up of a group of 3-story apartment buildings and/or 2 and 3-story row houses. Row houses predominate on southern projects while 4 and 5-story apartment buildings are used on some northern projects. All buildings are fireproof.

[2] Social and recreational units contained in space which might have been utilized for dwelling units have been considered as dwelling units.

[3] These data are based on the construction-contract price, less the estimated cost of the following facilities:

1. Dormitory buildings
2. Rentable office buildings
3. Store buildings
4. Garages
5. Social and recreational buildings
6. Electrical distribution systems, outside of buildings
7. Trunk-line and storm sewers
8. Street improvements, etc.

The cost of all other accessory buildings is included.

[4] Based on construction contract price.

Equipment Rental Prices In Five Areas

Equipment Rental Prices In Wisconsin

Item	Price per Month*
Backfiller	$250.00
Bins:	
Two comp., 50 ton	150.00
Two comp., 100 ton	180.00
Boilers, 40 hp	75.00
Buckets:	
Conc. contr. dump, 1 yd	35.00
Conc. contr. dump, 2 yd	50.00
Conc. tipover type, 1 yd	20.00
Clamshell, ¾ yd	90.00
Clamshell, 1 yd	115.00
Clamshell, 1½ yd	150.00
Dragline, 1 yd	115.00
Dragline, 1½ yd	150.00
Dragline, 2 yd	175.00
Orange peel, 1 yd	150.00
Chain falls, 5 ton	25.00
Compressors:	
Port. gas 105 ft	135.00
Port. gas 160 ft	200.00
Port. gas 210 ft	250.00
Port. gas 360 ft	350.00
Sta. 20x12, 100 hp, no power	150.00
Chutes, conc. 30 ft	10.00
Column clamps:	
36-in	.25
60-in	.35
Conveyor, belt:	
Gas or elec. 16-in., 32 ft	100.00
Gas or elec. 24-in., 32 ft	125.00
Cranes:	
Gas crawler, ¾ yd	450.00
Gas crawler, 1 yd	550.00
Gas crawler, 1½ yd	650.00
Locomotive, 20 ton	500.00
Derricks, steel:	
Stiffleg, 5 ton, 50 ft. bm	100.00
Stiffleg, 10 ton, 70 ft. bm	150.00
Guy, 5 ton, 50 ft. bm	100.00
Guy, 20 ton, 80 ft. bm	225.00
Drills, pneu. rock:	
Jackhammer	30.00
Wagon drills	125.00
Engines, gas:	
5 hp	20.00
15 hp	40.00
60 hp	80.00
Graders, road:	
Drawn, lean. wheel, 6,500 lb	135.00
Drawn, lean. wh. 11,000 lb. pow. contr.	250.00
Motor patrol, up to 12,500 lb	250.00
Motor patrol, over 12,500 lb	325.00
Hoists:	
Elec., 2 drum, 20 hp	65.00
Elec., 2 drum, 40 hp	90.00
Elec., 2 drum, 60 hp	115.00
Elec., 2 drum, 100 hp	150.00
Gas, single drum, 90 hp	55.00
Gas, single drum, 40 hp	80.00
Gas, single drum, 60 hp	135.00
Lighting units:	
Gas-elec. 2½ kw	50.00
Carbic	10.00
Mixers, concrete:	
Power loader, 7-S	50.00
Power loader, 14-S	150.00
Batch hopper 28-S	195.00
Paver, 27-E	500.00
Pile hammers:	
Union #6, McKiernan-Terry #2	60.00
Union #4, McK-T #5	90.00
Union #2, McK-T #7	125.00
Vulcan #1	150.00
Union #1, McK-T #9B2, Vulcan #0	200.00
Union #00, McK-T #11B2	275.00
Piledriver hanging leads, steel 50 ft	35.00
Pumps:	
Steam, 4-in. 1,150 gpm	85.00
Steam, 8-in. 2,000 gpm	125.00
Gas or elec. pressure 30 gpm	45.00
Gas or elec. pressure 40 gpm	65.00
Triplex, 100 gpm	125.00
Gas centrifugal, 2-in	40.00
Gas centrifugal, 3-in	50.00
Gas centrifugal, 4-in	75.00
Elec. centrifugal, 6-in	115.00
Hand diaphragm, 4-in	12.50
Power diaphragm, 4-in	40.00
Road finishing machines:	
9–20 ft	275.00
24–30 ft	350.00
Road rollers:	
Gas – 3 wheel, 10 ton	200.00
Gas – 3 wheel, 12–15 ton	250.00
Gas – tandem, 5 ton	150.00
Gas – tandem, 8 ton	175.00
Gas – tandem, 10 ton	200.00
Saws:	
Table, 8 hp. eng. two saws	50.00
Elec. hand, 8-in	30.00
Scrapers:	
Rollover, 27 c.f	40.00
Rollover, 56 c.f	75.00
Shores, each	.25
Shovels, gas crawlers:	
½ yd	450.00
¾ yard	550.00
1 yd	650.00
1¼ yd	700.00
1½ yd	750.00
Tractors:	
30 hp. bare	200.00
30 hp. bulldozer	275.00
50 hp. bare	325.00
50 hp. bulldozer	425.00
75 hp. bare	450.00
75 hp. bulldozer	600.00
Wagons, crawler dump, 5–8 yd	125.00

* Note: Prices are generally minimums; some items subject to discount for rental periods over one month; prices are for one shift 10 hr. or less per day, add 70 per cent for each additional shift.

New England

Item	Price per Month*
Aggregate bin and batcher:	
85 tons—with scales	$200.00
125 tons—with scales	350.00
Boilers:	
Up to 60 hp	75.00
60–100 hp	175.00
Buckets, clamshell or dragline:	
¾ yd	70.00
1 yd	90.00
1½	90.00
Compressors:	
Port. gas 60 ft	110.00
Port. gas 160 ft	275.00
Port. gas 210 ft	300.00
Port. gas 315 ft	350.00
Add for Diesel power	75.00
Conveyors, belt:	
Conc. crawler	300.00
Conc. wheel	175.00
Cranes and shovels:	
Gas crawler ¾ yd	450.00
Gas crawler 1 yd	550.00
Gas crawler 1½ yd	800.00
Gas crawler 2 yd	1,200.00
Add for Diesel power	75.00
Derricks, stiffleg:	
Price range	75.00 to 550.00
Drills, pneu. rock:	
Jackhammer	35.00
Wagon drills	150.00
Engines, gas:	
4 hp	75.00
8 hp	125.00
50 hp	175.00
100 hp	300.00
Graders, power:	
Under 20 hp	200.00
20–40 hp	300.00
40 hp. and over	450.00
Mixers, concrete:	
½ bag	75.00
1 bag	100.00
2 bag	125.00
Paver-27–E	550.00
Paver-double drum	1,550.00
Pumps:	
Centrifugal self-priming 2-in	70.00
Cent. s.p. 3-in	75.00
Cent. s.p. 4-in	85.00
Cent. s.p. 6-in	150.00
Hand pump	32.00
Wellpoint pump—up to 6-in	200.00
Road finishing machines:	
Ord, Lakewood or equal	400.00
Road forms:	
Steel—per 1,000 l.f	100.00
Road rollers:	
Gas—tandem 1½ ton	140.00
Gas—tandem 7–10 ton	225.00
Gas—3 wheel 10–14 ton	225.00
Steam—10 ton	160.00
Tractors:	
30 hp. bulldozer	325.00
50 hp. bulldozer	440.00
75 hp. bulldozer	600.00
Trailers, scrapers:	
Bottom dump semi trailer 8-yd.	$4.00 per hr.
Bottom dump semi trailer 10-yd.	$5.00 per hr.
Carryall and tractor 8-yd.	$8.00 per hr.
Carryall and tractor 12-yd.	$10.00 per hr.
Koehring trail dump	400.00
Vibrators:	
Concrete vibrator	125.00
Welding machine:	
Port. machine	550.00

* Daily and weekly rates also made, and rates 2 mo. or more, per month, are somewhat lower. Rates cover a ten-hour working day, six days per week. Overtime on rentals at the monthly rate is charged at 0.3 per cent of this rate per hr.

Cleveland Area

Item	Price per Month*
Bins:	
Two comp., 50 ton	$75.00
Two comp., 100 ton	120.00
Boilers, 40 hp	60.00
Buckets:	
Conc. contr. form, 1 yd	20.00
Conc. contr. form, 2 yd	25.00
Conc. tipover type, 1 yd	10.00
Clamshell, ¾ yd	55.00
Clamshell, 1 yd	75.00
Clamshell, 1½ yd	100.00
Dragline, 1 yd	90.00
Dragline, 1½ yd	100.00
Cars, dump:	
1 yd	15.00
1½ yd	20.00
2 yd	25.00
Chain falls, 5 ton	15.00
Compressors:	
Port. gas, 160 ft	200.00
Port. gas, 210 ft	250.00
Port. gas, 360 ft	350.00
Sta. 20x12, 100 hp., no power	150.00
Chutes, conc. 30 ft	10.00
Column clamps:	
36 in	.25
60 in	.35
Conveyor, belt:	
Gas or elec., 16 in., 32 ft	100.00
Gas or elec., 24 in., 32 ft	125.00
Cranes:	
Gas crawler, ¾ yd	450.00
Gas crawler, 1 yd	500.00
Gas crawler, 1½ yd	650.00
Derricks, steel:	
Stiffleg, 5 ton, 50 ft. bm	100.00
Stiffleg, 10 to, 70 ft. bm	150.00
Guy, 5 ton, 50 ft. bm	100.00
Guy, 20 ton, 90 ft. bm	200.00
Drills, pneu. rock:	
Jackhammer, 5 yd	35.00
Wagon drills	125.00
Engines, gas:	
5 hp	20.00
15 hp	40.00
60 hp	80.00
Graders, road:	
Drawn, lean, wheel, 6′ to 7′ blade	85.00
Drawn, lean. wh., 10′ blade	110.00
Motor patrol, 10–15 hp	250.00
Motor patrol, 30 hp	350.00
Hoists:	
Elec., 2 drum, 20 hp	75.00
Elec., 2 drum, 40 hp	100.00
Elec., 2 drum, 60 hp	125.00
Elec., 2 drum, 100 hp	150.00
Gas, single drum, 20 hp	60.00
Gas, single drum, 40 hp	90.00
Gas, single drum, 60 hp	100.00
Lighting units:	
Electric flood	10.00
Carbic	10.00
Mixers, concrete:	
Power loader, 7-S	80.00
Power loader, 14-S	100.00
Power loader, 21-S	125.00
Batch hopper, 28-S	150.00
Paver, 27-E	500.00
Pile hammers:	
McKiernan-Terry #2	60.00
McKiernan-Terry #5	90 00
McKiernan-Terry #7	125 00
Vulcan #1	150.00

McKiernan-Terry #9B2	175.00
McKiernan-Terry #11B2	275.00
Piledriver hanging leads, steel 50 ft.	35.00
Pumps:	
Steam, 4-in., 450 gpm	50.00
Steam, 8-in., 2,000 gpm	125.00
Gas, pressure, 30 gpm	45.00
Elec., pressure, 50 gpm	70.00
Gas centrifugal, 2-in	35.00
Gas centrifugal, 3-in	45.00
Gas centrifugal, 4-in	75.00
Elec. centrifugal, 6-in	80.00
Hand diaphragm, 4-in	12.50
Power diaphragm, 4-in	50.00
Road finishing machines:	
9–12 ft.	300.00
24–30 ft.	350.00
Road rollers:	
Gas, 3 wheel, 10 ton	200.00
Gas, 3 wheel, 12–15 ton	250.00
Gas, tandem, 5 ton	150.00
Gas, tandem, 8 ton	175.00
Gas, tandem, 10 ton	200.00
Road subgraders:	
9–12 ft.	100.00
15–20 ft.	125.00
24–30	150.00
Saws:	
Table, 8 hp. eng., two saws	50.00
Elec. hand, 8 in	40.00
Shores, each	.30
Tractors:	
30 hp., bare	275.00
30 hp., bulldozer	350.00
50 hp., bare	350.00
50 hp., bulldozer	450.00
Trenching machine	350.00
Wagons, crawler dump, 5–8 yd.	250.00

* Note: Prices are generally minimums; some items subject to discount for rental periods over one month; prices are for one shift 10 hr. or less per day, a charge is made on overtime in excess of 10 hours per day.

Philadelphia Area

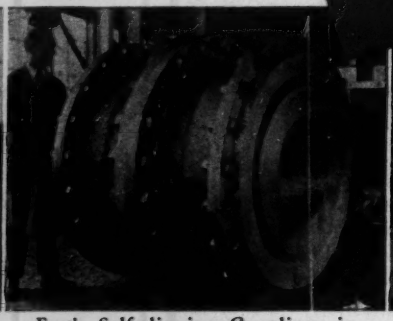
Item	Price per Month
Backfiller	$200.00
Bins:	
Two comp. 50 ton	200.00
Two comp. 100 ton	300.00
Boilers:	
40 hp.	85.00
Buckets:	
Conc. cont. dump 1 yd.	35.00
Conc. cont. dump 2 yd.	50.00
Conc. tipover type	20.00
Clamshell ¾ yd.	100.00
Clamshell, 1 yd.	120.00
Clamshell, 1½ yd.	160.00
Dragline, 1 yd.	115.00
Dragline, 1½ yd.	150.00
Dragline, 2 yd.	175.00
Orange peel 1 yd.	150.00
Cars dump:	
4 yd.	30.00
5 yd.	35.00
Chain falls:	
5-ton	35.00
Compressors:	
Port. gas 160 ft.	175.00
Port. gas 210 ft.	225.00
Port. gas 360 ft.	300 00
Chutes:	
Conc. 30 ft.	10.00
Column clamps:	
36-in.	.25
60-in.	.35
Conveyor belt:	
Gas or elec. 16-in. 32 ft.	100.00
Gas or elec. 24-in. 32 ft.	125.00
Cranes:	
¾ yd.	500.00
1 yd.	550.00
1½ yd.	850.00
Derricks, steel:	
Stiffleg, 5 ton, 50 ft. bm	100.00
Stiffleg, 10 ton, 70 ft. bm	150.00
Guy, 5 ton, 50 ft. bm.	100.00
Guy, 20 ton, 80 ft. bm.	225.00
Drills, pneu. rock:	
Jackhammer	35.00
Wagon drills	150.00
Engines, gas:	
5 hp.	20.00
15 hp.	40.00
60 hp.	80.00
Graders, road:	
Drawn, lean, wheel 6,500 lb.	135.00
Drawn, lean, wh. 11,000 lb. pow. contr.	250.00
Motor patrol, up to 12,500 lb.	250.00
Motor patrol, over 12,500 lb.	325.00
Hoists:	
Elec. 2 drum, 20 hp	90.00
Elec. 2 drum, 40 hp.	125.00
Elec. 2 drum, 60 hp.	170.00
Elec. 2 drum, 100 hp.	210.00
Gas, single drum, 20 hp.	75.00
Gas, single drum, 40 hp.	100.00
Gas, single drum, 60 hp.	140.00
Lighting units:	
Gas-elec. 2½ kw.	50.00
Carbic	10.00
Mixers, concrete:	
Power loader, 7–S.	90.00
Power loader, 14–S.	160.00
Power loader, 21–S.	175.00
Batch hopper, 28–S.	200.00
Batch hopper, 56–S.	375.00
Paver, 27–E.	650.00
Pile hammers:	
Union #6, McKiernan-Terry #2	85.00
Union #4, McK-T #5	120 00
Union #2, McK-T #7	168.00
Vulcan #1	200.00
Union #1, McK-T #9B2, Vulcan #0	240.00
Union #00, McK-T #11B2	300.00
Piledriver hanging leads, steel 50 ft.	50.00
Pumps:	
Gas cent. 2-in.	50.00
Gas cent. 3-in.	65.00
Gas cent. 4-in.	75.00
Hand diap. 4-in.	15.00
Power diap. 4-in.	50.00
Road Finishing Mach.– 9–20 ft.	300.00
Road forms:	
8–9 in. per ft.	.10
10-in per ft.	.125
Rollers:	
10-ton	300.00
5-ton	150.00
Road subgraders:	
9–12 ft.	50.00
15–20 ft.	75.00
24–30 ft.	150.00
Saws:	
Table, 8 hp. eng., two saws	50.00
Elec. hand, 8-in.	30.00
Shovels:	
½ yd.	400.00
¾ yd.	500.00
1 yd.	550 00
1¼ yd.	650.00
1½ yd.	850.00
Tractors:	
30 hp., bare	225.00
30 hp., bulldozer	275.00
50 hp., bare	350.00
50 hp., bulldozer	425.00
75 hp., bare	450.00
75 hp., bulldozer	550.00
Trenching machines	500.00
Welding Machines:	
200 amp.	125.00
300 amp.	150.00

Upper Ohio Valley

Item	Price per Month*
Backfiller	$250.00
Bins:	
Two comp., 50 ton	150.00
100 ton weigh batchers	250.00
Boilers, 40 hp.	75.00
Buckets:	
Conc. contr. dump, 1 yd.	35.00
Conc. contr. dump, 2 yd.	50.00
Conc. tipover type, 1 yd.	20.00
Clamshell, ¾ yd.	90.00
Clamshell, 1 yd.	115.00
Clamshell, 1¼ yd.	150.00
Dragline	115.00
Dragline, 1½ yd.	150.00
Dragline, 2 yd.	175.00
Orange peel, 1 yd.	150.00
Cars, dump:	
4 yd.	30.00
6 yd.	50.00
12 yd.	60.00
20 yd.	100.00
30 yd.	125.00
Chain falls, 5 ton	50.00
Compressors:	
Port. gas, 160 ft.	175.00
Port. gas, 210 ft.	200.00
Port. gas, 360 ft.	300.00
Sta. 20x12, 100 hp., no power	150.00
Chutes, cone, 30 ft.	10.00
Column clamps:	
36 in.	.25
60 in.	.35
Conveyor, belt:	
Gas or elec., 16 in., 32 ft.	100.00
Gas or elec., 24 in., 32 ft.	125.00
Cranes:	
Gas crawler, ¾ yd.	500.00
Gas crawler, 1 yd.	550.00
Gas crawler, 1½ yd.	650.00
Locomotive, 20 ton	600.00
Derricks, steel:	
Stiffleg, 5 ton, 50 ft. bm.	100.00
Stiffleg, 10 ton, 70 ft. bm.	200.00
Guy, 5 ton, 50 ft. bm.	100.00
Guy, 20 ton, 80 ft. bm.	225.00
Drills, pneu. rock:	
Jackhammer	30.00
Wagon drills	125.00
Engine, gas:	
5 hp.	20.00
15 hp.	40.00
60 hp.	80.00
Graders, road:	
Drawn, lean, wheel, 6,500 lb.	135.00
Drawn, lean, wh., 11,000 lb. pow. contr.	250.00
Motor patrol, up to 12,500 lb.	125.00
Motor patrol, over 12,500 lb.	170.00
Hoists:	
Elec., 2 drum, 20 hp.	70.00
Elec., 2 drum, 40 hp.	125.00
Elec., 2 drum, 60 hp.	150.00
Elec., 2 drum, 100 hp.	200.00
Gas, single drum, 20 hp.	80.00
Gas, single drum, 40 hp.	110.00
Gas, single drum, 60 hp.	135.00
Lighting units:	
Carbic	10.00
Locomotives:	
Gas or diesel, 6–8 ton	200.00
Gas or diesel, 10 ton	250.00
Gas or diesel, 12 ton	300.00
Gas or diesel, 15–18 ton	450.00
Gas or diesel, 20 ton	600.00
Gas or diesel, 25 ton	750.00
Steam, 13x18, 14x20	400.00
Steam, 16x24, 18x24	500.00
Mixers:	
Power loader, 7–S.	85.00
Power loader, 14–S.	135.00
Power loader, 21–S.	165.00
Batch hopper, 28–S.	195.00
Batch hopper, 56–S.	350.00
Paver, 27–E.	500.00
Pile hammers:	
Union #6, McKiernan-Terry #2	60.00
Union #4, McK–T #5	100.00
Union #2, McK–T #7	150.00
Vulcan #1	200.00
Union #1, McK–T #9B2	200.00
Union #00, McK–T #11B2	275.00
Piledriver hanging leads, steel 50 ft.	35.00
Pumps:	
Steam, 6 in., 1,150 gpm	85.00
Steam, 8 in., 2,000 gpm	125.00
Gas or elec., pressure, 30 gpm	45.00
Gas or elec., pressure, 40 gpm	65.00
Triplex, 100 gpm.	150.00
Gas centrifugal, 2 in.	40.00
Gas centrifugal, 3 in.	50.00
Gas centrifugal, 4 in.	75.00
Elec. centrifugal, 6 in.	115.00
Hand diaphragm, 4 in.	12.50
Power diaphragm, 4 in.	40.00
Road finishing machines:	
9–20 ft.	275.00
24–30 ft.	350.00
Road forms:	
8–9 in. per ft.	.10
10 in., per ft.	.125
Road rollers:	
Gas, 3 wheel, 10 ton	225.00
Gas, 3 wheel, 12–15 ton	275.00
Gas, tandem, 5 ton	175.00
Gas, tandem, 8 ton	200.00
Gas, tandem, 10 ton	225.00
Road subgraders:	
9–12 ft.	50.00
15–20 ft.	75.00
24–30 ft.	150.00
Saws:	
Table, 8 hp. eng., two saws	50.00
Elec. hand, 8 in.	40.00
Scrapers:	
Rollover, 27 c.f.	40.00
Rollover, 56 c.f.	125.00
Shores, each	.25
Shovels, gas crawler:	
½ yd.	450.00
¾ yd.	550.00
1 yd.	650.00
1¼ yd.	700.00
1½ yd.	750.00
Tractors:	
30 hp. bare	175.00
30 hp. bulldozer	250.00
50 hp. bare	250.00
50 hp. bulldozer	300.00
75 hp. bare	450.00
75 hp. bulldozer	650.00
Trench brace, dos	6.00
Trenching machine	500.00
Wagons, crawler dump, 5–8 yd.	125.00
Welding machines:	
200 amp.	125.00
300 amp.	150.00

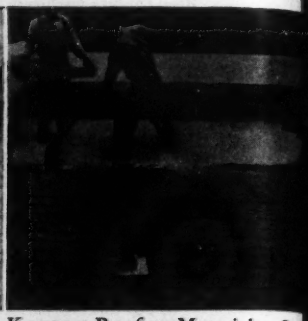
* Note: Prices are generally minimums; some items subject to discount for rental periods over one month; prices for one shift 10 hr. or less per day, add 50 per cent for extra shift; 100 per cent for 24-hr. service.

Tarmac Paving for roads, streets, walks, drives, parking areas.

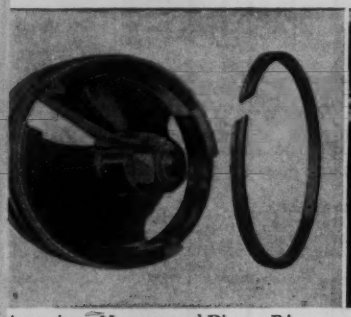


Fast's Self-aligning Couplings in all types and sizes.

Pressure-treated Timber for bridges, piling, poles, posts, structural work.



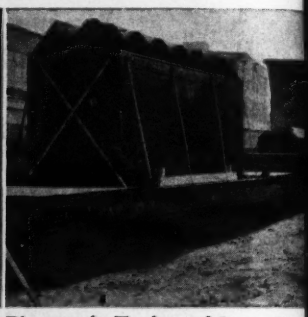
Koppers Roofing Materials—Coal Tar Pitch and Tar-Saturated Felt



American Hammered Piston Rings and Cylinder Packing.

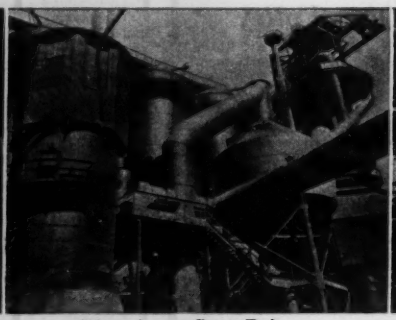
Coal and Coke.

Waterproofing Materials—Coal Tar Pitch, Felt and Fabric.

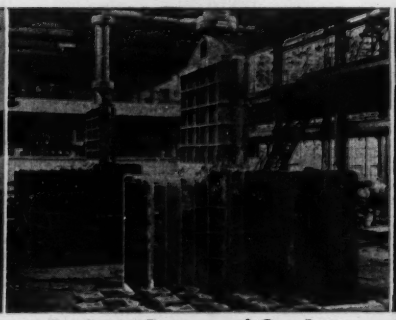


Platework, Tanks and Large Pipe.

D-H-S Bronze Forgings and Castings.



Bituminous Base Paints.



Castings—Bronze and Cast Iron.

Creosote—for the preservative treatment of wood.

KOPPERS COMPANY · PITTSBURGH, PA.

Koppers Divisions, Subsidiaries, Affiliates: American Hammered Piston Ring Division, Bartlett Hayward Division, Boston Tow Boat Company, Eastern Gas and Fuel Associates, Engineering and Construction Division, Gas and Coke Division, The Koppers Coal Company, Koppers-Rheolaveur Company, The Maryland Drydock Company, Mystic Iron Works, Mystic Steamship Company, New England Coal & Coke Company, Tar and Chemical Division, The White Tar Company of New Jersey, Inc., The Wood Preserving Corporation.

OTHER KOPPERS PRODUCTS

Coke and Gas Plants, Purification & Recovery Equipment, Boiler and Power Plants, Industrial Electric Power Plants, Industrial Chemicals, Incinerators, Special Machinery, Materials-handling Systems, Drydocking Facilities, Hot Metal Transfer Cars, Time Cycle Controls, Disinfectants, Tar Acids and Light Oils, Gas Holders

KOPPERS products